INSTRUMENTS and AUTOMATION

NOV 26 1956
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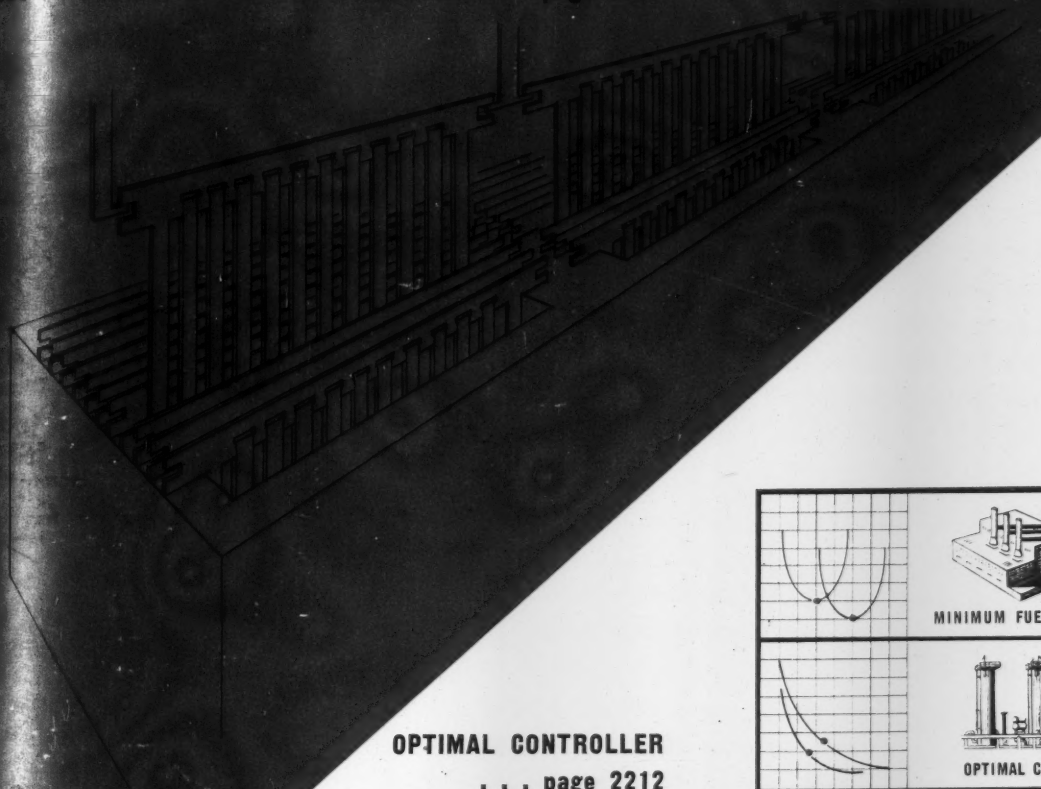
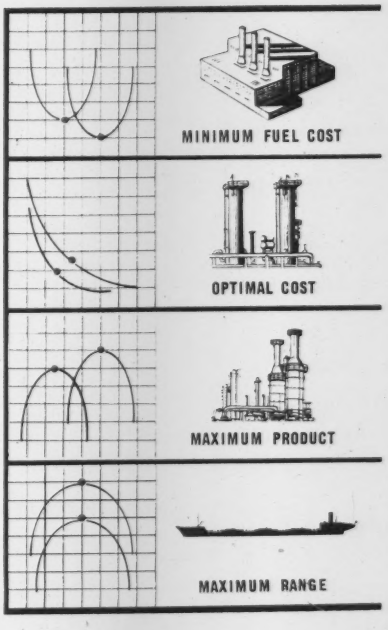
500,000-BIT RANDOM-ACCESS MEMORY . . . page 2208



DISCLOSURE 2



OPTIMAL CONTROLLER
. . . page 2212

NOVEMBER 1956

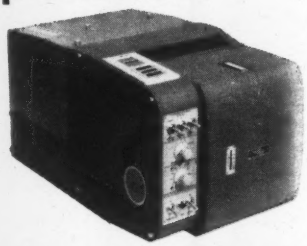
Including:
Instrument Manufacturing
The Journal of the SCMA
Simulation Council Newsletter

See this oscillograph and other Midwestern test instruments and servo components at the

AUTOMATION EXPOSITION
Booth 441
Nov. 26-30

A MIDWESTERN OSCILLOGRAPH for every recording application

This tabulation shows the many types of MIDWESTERN recording oscillographs available today.



SPECS

Model	Maximum Trace Capacity (1)	Dimensions Inches (2)	Weight Pounds (3)	Record Speed Range Inches/Sec	Record Width Inches	Magazine Capacity Feet (5)	Power Requirements	Timing Lines Sec/Line	Optical Arm Inches	Temperature Range °F	Maximum Acceleration G's	Model
580	14	5¾ x 6⅝ x 7 1/16	8	.375 To 8	3.625	50	28 Volts d.c. 3 Amps Max.	——	6.921	0 to + 160	20 (8)	580
580		7⅛ x 7⅛ x 13½	22.5	.50 To 44.75 (4)		100	28 Volts d.c. 15 Amps Max.	.01 And/Or .10	7.375	—65 to + 190	20	580
581		7⅛ x 7⅛ x 15⅜	28.5									581
544	36	11½ x 12⅜ x 20	75	1 To 50	8	200	28 Volts d.c. 10 Amps Max. or 115 Volts, 60 cps 3 Amps Max.		14.469	+ 32 to + 160	1	544
570	50	11½ x 16⅛ x 20	97		12							570
590	36	11 x 11⅝ x 21⅞	90	.082 To 129.9	7	150	(6)	(7)	11.00	—65 to + 160	15	590
591	50	11 1/16 x 16 13/16 x 24¾	130		12	250						591

FEATURES

Model	Record Numbering	Trace Identification	Automatic Record Length	Timing Line Intensity Control	Galvo Lamp Intensity Control	Record Used Indicator	Recording Malfunction Indicator	Galvo Lamp Burnout Indicator	Timing Lamp Burnout Indicator	Rotary Scanning	Remote Control	Model
560	——	——	——	——	√	——	——	——	——	——	——	560
580	——	√	——	√	√	√	——	√	√	——	√	580
581	√	√	√	√	√	√	√	√	√	——	√	581
544	√	√	√	(9)	√	√	√	√	(9)	√	√	544
570	√	√	√		√	√	√	√		√	√	570
590	√	√	√		√	√	√	√		√	√	590
591	√	√	√		√	√	√	√		√	√	591

NOTES
(1) Using MIDWESTERN 102 Galvanometers.
(2) Dimensions include all external controls and fittings but do not include mating electrical connectors or shock-mount base.
(3) Weight does not include shock-mount base.
(4) A low speed version of these models is available with all recording speeds reduced by a factor of 60.
(5) Listed magazine capacities are with Kodak Linagraph #809 Paper. Other standard recording paper or film may also be used. Larger capacity magazines are available for the 580, 581, 590, and 591 Models.
(6) May be operated from 28 volts dc, 15 amps max.; or 115 volts, 60 or 400 cps single phase, 5 amps max. by means of interchangeable plug-in power supply units.
(7) Timing lines of .001 and/or .01; .01 and/or .10; or .10 and/or 1.0 seconds intervals, by means of interchangeable plug-in units.
(8) A special version of this model is available which will withstand shock accelerations in excess of 1000 gravities.
(9) Timing lines are produced by electronic flasher-tubes. Due to their much longer operating life, warning indicators are not required; and because of their flash illumination characteristic, intensity adjustments are not necessary.

for complete details on the above oscillographs — and other MIDWESTERN test recording instruments and servo components — write

MIDWESTERN INSTRUMENTS

41st and Sheridan Road • Tulsa, Oklahoma

For more information circle **1** on inquiry card.

New 1 KVA Perkin

Tubeless magnetic amplifier

AC Line Regulator features ±0.25% regulation accuracy

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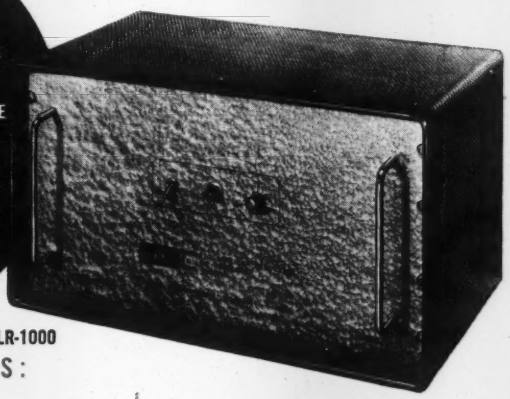

Model MLR-1000

SPECIFICATIONS:

Input voltage range: 95 to 135 volts

Output voltage: Nominal 115 volts, can be adjusted from 110 to 120 v.

Output current: 8.5 amperes

Frequency range: 60 cycles ±10%

Wave form distortion: 3% max.

Power factor range: 0.5 lagging to 0.9 leading

Response time: 0.2 sec.

Maximum load: 1.0 KVA

Ambient temp. range: Up to 45° C

Dimensions: 19½" wide x 11½" high x 11½" deep (Cabinet)
19" wide x 10½" high x 10" deep (rack panel)

Mounting: Cabinet or 19" rack panel

Finish: Gray hammertone

Weight: 85 lbs.

Also available—3 KVA Model MLR-3000, same specifications except: output current 25.5 amps. Dimensions 19" wide, 14¾" deep x 12¼" high (rack) or 19½" wide x 16¼" deep x 12¾" high (cabinet). Weight 170 lbs.

PERKIN

DC POWER SUPPLIES

Perkin also manufactures a complete line of standard DC power supplies as listed below:

28 VOLT DC POWER SUPPLIES:

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VPM	0-32 V	5	20% (24-32 V range)	115 V 1 phase	2%
28-10WX	24-32 V	10	±½%	100-125 V 1 phase	1%
MR332-15A	2-36 V	15	±½%	105-125 V 1 phase	1%
28-15VPM	0-32 V	15	20% (24-32 V range)	115 V 1 phase	5%
M80V	0-32 V	25	±1%	115 V 1 phase	1%
MR1040-30A	5-40 V	30	±1%	100-130 V 1 phase	1%
28-30WXM	24-32 V	30	±½%	100-125 V 1 phase	1%
28-50WX	24-32 V	50	±½%	230 V* 3 phase	1%
MR2432-100XA	24-32 V	100	±½%	208, 230, 460 V ±10% 3 phase	1%
MR2432-200	24-32 V	200	±½%	230 V* 3 phase	1%
MR2432-300	24-32 V	300	±½%	230 V* 3 phase	1%
MR2432-500	24-32 V	500	±½%	230 V* 3 phase	1%

*±10%. Also available in 460 V ±10% AC input. Will be supplied with 230 V input unless otherwise specified.

6, 12, 115 VOLT DC POWER SUPPLIES:

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
6-8WX	6 ±10%	8	±1%	95-130 V 1 phase	1%
6-15WX	6 ±10%	15	±1%	95-130 V 1 phase	1%
6-40WX	6 ±10%	40	±1%	95-130 V 1 phase	1%
12-15WX	12 ±10%	15	±1%	95-130 V 1 phase	1%
115-8WX	115 ±10%	8	±½%	95-130 V 1 phase	1%
MR115120-8	15-125	8	±1%†	95-130 V 1 phase	1%†
6120-28**	115-125	28	1½-4%	230/460 V 3 phase	6%

**Saturable Rectifier Unit. †Increases to 2% @ 15 V.

PERKIN SALES OFFICES:

New York area N.J.
Newark MArket 3-1454
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BR 4-9135
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PA 5-7701
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VA 1-5330
Dallas
FO 8-8306
Denver
MA 3-0343
San Francisco area
(Palo Alto)
DAvenport 5-6136
Los Angeles
RY 1-8810
Pittsburgh
WA 1-2959
Minneapolis
MI 4-7884
Seattle
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PERKIN ENGINEERING CORPORATION

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Manufacturer of
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Gauge and Embossing Points

For more information circle **5** on inquiry card.

Letters to the editor

Editor, I&A

In a recent issue of *I&A* you ask for comments on the definitions of automation proposed by you and by RETMA:

Automation (MHA): the use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for performing automatic decisions and efforts.

Automation (RETMA): the technique of improving human productivity in the processing of materials, energy and information, by utilizing, in various degrees, elements of self-control and of automatically executed product programming.

Compared to the RETMA definition, the income-tax regulations are kindergarten English. In fact, "Improving *human* productivity . . . by utilizing . . . *self control* . . ." is the precise antithesis of the generally accepted idea of automation.

Your definition is OK.

Walter R. Falk
Walter R. Falk Company
Philadelphia 3, Pa.

Editor, I&A:

After studying both your own and the RETMA definition of automation, I submit my own, in the interests of clarity and correctness—"Automation is the automatic control of continuous processes."

This definition signifies a difference between automatic control and automation. A machine performing a single operation—such as a card-programmed boring mill—is an automatic machine, of a very complex type, but nothing more. It may be used as part of an automated process, but by itself it is not automated.

Marvin M. Fromm
Pittsburgh 17, Pa.

Mr. Falk points out a basic inconsistency in the RETMA definition. The difference between the definition of Fromm and that of your editor is one of philosophy. Mr. Fromm would distinguish between automatic control and automation, reserving the latter for continuous processes only. Your editor thinks such a distinction, however admirable in concept, would be difficult to promote to the point of common acceptance (the final judge in all matters of definition). Our philosophy is simply that automation is a short word for automatic control, a contraction of the words automatic operation.

This difference in philosophy underlies much of the discussion on definitions of automation. Is automation high-level automatic control, or any type of automatic control? In matters of definition, the individual proposes, but public opinion disposes—and most people think of automation as "the use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for performing automatic decisions and efforts"—*any* decisions or *any* efforts.

In fact, Mr. Fromm has picked a device that most people believe to be pure automation as an example of what, according to his definition, is *not* automation.

Editor, I&A:

We have developed a number of new measuring devices and control systems which I believe would be of interest to your readers. Our company specializes in industrial instrumentation at a consulting level.

If at all possible, we would like to have some information on them placed in the "New Products" section of your magazine.

I read your magazine every month and would like to add my congratulations on the fine presentation in the August issue. You are doing industry a real service; keep up the good work.

Robert C. Cahill,
Vice-President
Ramsey Engineering Co.
2451 University Avenue
St. Paul 14, Minn.

Thank you for your kind letter. If your devices are available commercially, send us a brief description of 100 to 200 words with a glossy photograph showing the device. We will

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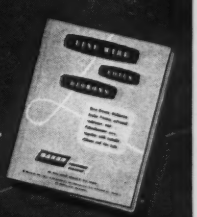

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UNMATCHED ACCURACY
in direct flow indication
Wherever you seek simplicity and high accuracy in flow measurement at lowest cost, the Meriam "H" Meter is the well-known answer.
Here is an easy-to-install flowmeter . . . free of all conventional service requirements . . . giving long-term economy as well as low initial cost. There are no pressure tight bearings . . . no magnetic followers . . . no stuffing boxes . . . no hysteresis problems whatsoever. No calibration is ever required, yet you have the highest accuracy available.
★ High operating pressures
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...for pressures, vacuums, flows, liquid levels.
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For more information circle 7 on inquiry card.

LETTERS—CONTINUED

then publish it in the industry's only complete monthly review of new products—the New Instruments Dept. of I&A.

Editor, I&A:

Your use of the word "Titrimeter" on page 187 of the *Handbook of Measurement and Control* has been brought to my attention.

"Titrimeter" is a trademark owned by Fisher Scientific Company and registered by Fisher Scientific Company in the United States Patent Office.

George D. Welch,
Advertising Manager
Fisher Scientific Company
Pittsburgh, Pa.

Sorry.

Editor, I&A:

In the September issue of *Instruments and Automation*, you state that a national steel concern intends to form a "systems evaluation group." I would like to find out more about this "group," particularly who, where and how?

Presently I am employed as senior project engineer . . . . the work entails design of electromechanical computers for automatic inertial guidance systems and antenna servo drives . . . I would like to return to industrial work.

R. L.
Beaver Falls, Pa.

The significance of this letter lies in the fact that heavy industry can tap the tremendous new skills developed in the aircraft industry. There are many indications that this is about to happen. The reader, like many others, has been put in touch with the steel company now planning a systems and simulation approach to its operations.

Editor, I&A:

Please accept my thanks for the "Inchworm" story that appeared in your magazine . . . the response from technical personnel as well as buyers of our kind of equipment has been overwhelming and we honestly feel that your magazine contributed a great deal to this response.

Harold Hechtman,
Asst. to the Pres.
Airborne Instruments Laboratory
Mineola, N. Y.

Editor, I&A:

As one of your subscribers to *Instruments & Automation* may we compliment you and your staff on the excellent presentation of information in each and every issue.

Many of the Letters-To-The-Editor that you publish in *Instruments & Automation* comment very favorably on the usefulness of your *Catalog & Index of Instrument Manufacturers*. I feel that an index of this type would be a valuable asset to our present file of suppliers.

I will appreciate receiving information concerning availability, price, and method of obtaining one (1) copy of the above mentioned index.

John W. Allen,
Assistant Director
Aircraft-Marine Products Inc.
Carlisle, Pa.

Thank you for your nice letter. Subscribers received as part 2 of their October issue the Instruments and Automation Handbook & Buyers' Guide. You can start your subscription with the October issue and receive the Handbook and Buyers' Guide.

Editor, I&A:

I have just seen the letter to the Editor (from Lyman Nichols, Cherryhurst, Fort Collins, Colorado) published in the September issue of *Instruments and Automation*, page 1703. We are presently using spherical engraved compass cards on our well surveying instruments, of the form and size shown in the enclosed sample.

This material in nylon, and the black-and-white contrast of the filled engraving gives sufficient contrast for photography. We also make these cards of anodized aluminum, dyed black, then engraved and filled with white pigment.

We would like to make these cards half this size. Perhaps Mr. Nichol's method of micro engraving can produce better copy, even though smaller, and still giving good photography.

The enclosed sample will show you what our problem is, and what we hope to do.

Marion H. Morris
Development Engineer
Sperry-Sun Well Surveying Company
131 University Avenue
Palo Alto, Calif.

Editor, I&A:

This acknowldges receipt of your letter in the matter of manufacturers of the electrical signal control board

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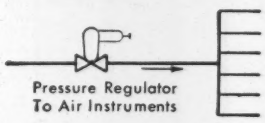
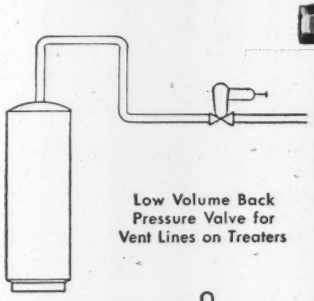
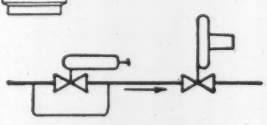


Pressure Regulator To Air Instruments

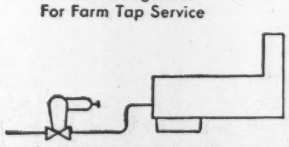
Pressure Regulator For High Pressure Gas Bulk Storage



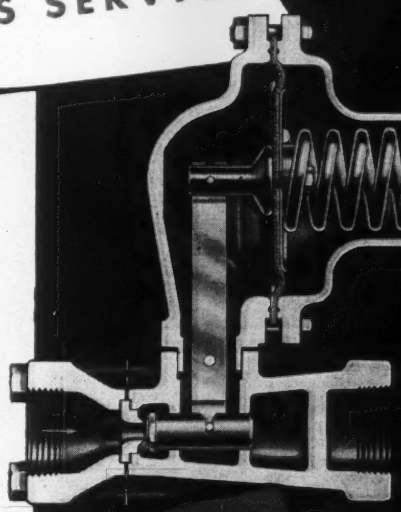
Low Volume Back Pressure Valve for Vent Lines on Treaters



Pressure Regulator For Farm Tap Service



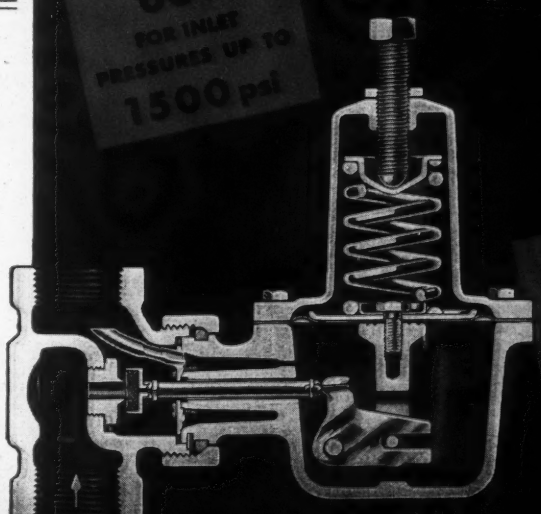
Reducing Valve for Heater Fuel or Treater Furnace Fuel



Fisher's famous Big Joe Type 630 is the best regulator the industry has for rugged high pressure jobs. It's ideal for countless numbers of industrial applications where it is necessary to reduce high pressure air or gas to a constant supply pressure of 5 to 200 psi. Valve disc material: Up to 200 psi inlet BunaN is furnished. 200 psi inlet and above, Nylon is furnished. (Teflon is available when specified.)

Available in 1" and 2" sizes for inlet pressures up to 1500 psi and outlet pressures 5 psi to 200 psi.

TYPE 630 FOR INLET PRESSURES UP TO 1500 psi



TYPE 620 FOR INLET PRESSURES UP TO 750 psi

For real economy the Fisher Type 620 pounds to pounds regulator is used on same applications as 630 "Big Joe" where pressure and flow requirements do not exceed 750 psi and reduced pressure not above 100 psi.

For inlet pressures up to 750 psi with malleable iron or cast steel body; up to 150 psi with cast iron body. Outlet pressure ranges: Type 620—3 to 60 lbs. (4 springs). Type 621—3 to 100 lbs. (5 springs). Valve disc material: BunaN when inlet pressure is 300 psi or less, and Nylon when inlet pressure exceeds 300 psi.

Sizes: ¾", 1" and 1¼" with cast iron or cast steel body. ¾" and 1" with malleable iron body.

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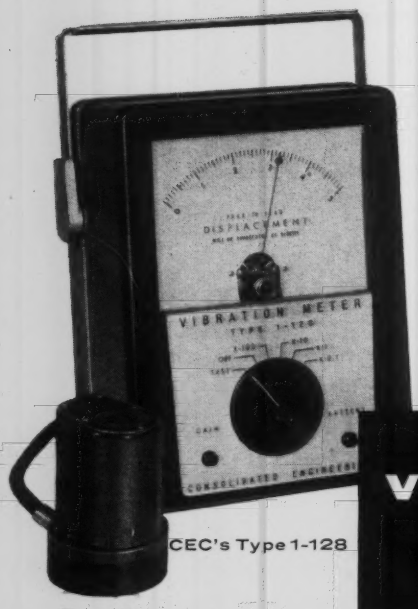
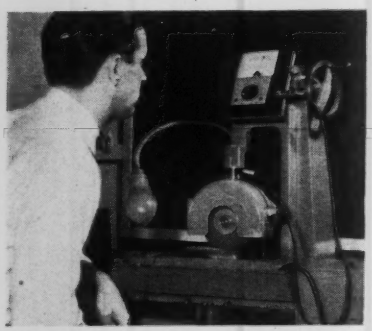


CEC's Type 1-128

easiest way to measure vibration anywhere

VIBRATION METER



Vibration which can shorten the life of machinery and adversely affect product quality is indicated by the 1-128 used in the shop.

Bearing vibration in the motor-driven pump unit of a gas plant is monitored in a hazardous location by the portable 1-128.

PORTABLE . . . Carry this precision instrument *anywhere* for vibration analysis in either shop, field, or mobile applications.

NO POWER CABLES . . . An *all-transistor, etched-circuit* design, the 1-128 Vibration Meter is battery-powered . . . weighs only 7½ lbs.

SELF-CONTAINED . . . With the addition of a linear or torsional vibration pickup, the convenient 1-128 becomes a completely self-contained monitoring system. Peak-to-peak displacements as small as 0.0005″ are indicated on the large, easy-to-read meter over the frequency range of 10 to 1000 cycles.

VERSATILE . . . An oscilloscope can be coupled to the meter through an output jack. Simple to operate and designed to meet adverse environmental conditions, your CEC 1-128 will pay for itself many times over. For full information, please write for Bulletin CEC 1566-X27.

Consolidated Electrodynamics

CEC

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

For more information circle 9 on inquiry card.

LETTERS —CONTINUED

we have in mind, I want to thank you for having sent us such a comprehensive list. We have already written to these companies and have mentioned the fact that we addressed them at the suggestion of "*Instruments and Automation.*"

I would also like to impress you with the importance of the service that such information renders to someone like ourselves who are confronted all at once with the necessity of canvassing the entire instrument field in order to find a particular device. This service has saved us a considerable amount of time in rummaging through suppliers' catalogues and in interviewing salesmen for a number of weeks before the actual source is found.

A. T. Gaudreau
Jackson Brewing Co.
New Orleans 7, La.

Editor, I&A:

Being a steady reader of your magazine "Instruments & Automation," I have found your publication keeps me up to date with the latest developments available, so much so that I look to you as my standard source of reference.

Recently I have been compiling a list of instrument dealers, especially related to temperature and humidity measurements and control. Could you possibly inform me where such a listing is available? Manufacturers names are readily obtainable, but I have found a dealer list harder to locate.

Norman C. Molz
Bendix Aviation Corp.
Friez Instrument Div.
Baltimore 4, Md.

Our list of manufacturers agents or representatives who sell instruments has the names of about 1,800 such dealers, not all of whom sell temperature and humidity instruments, but many of whom do. We would be pleased to have you look over the list at your convenience. Many manufacturers send their sales managers to our office for such purposes.

Editor, I&A:

I have rough drafts of two articles that I am preparing for you, but I've been unable to complete them.

You might be interested to know that I've received many letters, including overseas correspondence, on

late articles appearing in your magazine. The letters, by the way, were highly enthusiastic. Mr. Steinberg, Public Relations Manager of Gulton Industries, wrote indicating that they expect to have quite a number of my "Accelerometer Calibration by Ballistic Pendulum" (*I&A*, July, 1956) article reproduced for distribution.

Alvin B. Kaufman
Los Angeles, Calif.

Alvin Kaufman is the prolific author of useful technical articles whom you met in the "Biographies" feature of our Dec., 1955 issue.

Editor, I&A:

Amen again (to the comment that your magazine is too theoretical and impractical). It has lost its value to the average plant or design engineer who is of necessity an overall man and not a specialist.

(Unsigned)
Phoenix, Arizona

Although we seldom pay much attention to unsigned letters, this man was a subscriber to *I&A* and hence deserves an answer. As *I&A* is the most practical of the present-day instrumentation books, this reader presumably has given up reading of magazines by dropping his subscription. To him we repeat a paragraph from our August editorial (page 1513):

"Failure to accommodate to change has become too common at all levels of our society . . . our jobs no less than our lives will change as the years go by. Such change is inevitable, and it is every man's personal responsibility to devote a portion of his time to advancement within his field." Following this comment, the entire editorial "A Process Lag?" on page 1513 of the August issue, is written just for this man, and he should reflect on it a little.

We have a hunch this man will still be reading I&A in the future—and he will be pleased to learn that we are planning a complete home-study course on basic instrumentation—starting with manometers and pressure gages.

Editor, I&A:

Find enclosed check for $14.00 for seven group subscriptions to *Instruments & Automation*.

Your magazine is doing an excellent job for anyone using instruments.

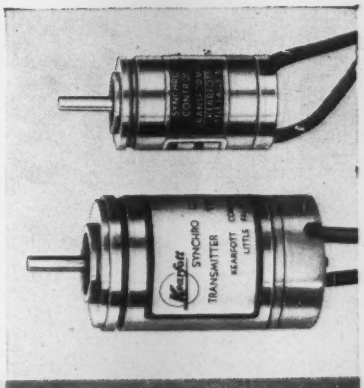
Harry G. Bangerter
Douglas Aircraft Co.
Long Beach 1, Calif.

SIZE 8 (R1000 Series)

.750 x 1.240 inches, weighs 1.75 oz. Available as transmitters, control transformers, resolver and differentials. Max. error from EZ 10 minutes.

SIZE 11 STANDARD (R900 Series)

1.062 x 1.766 inches, weighs 4 oz. Available as transmitters, control transformers, repeaters, resolvers and differentials for 26V and 115V applications. Max. error from EZ 10 minutes.

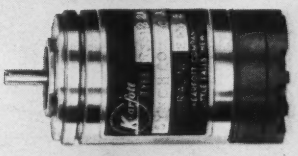


SYNCHROS

STANDARD AND SPECIAL

SIZE 11 SPECIAL (R500 Series)

Same basic dimensions and applications as standard Size 11 Synchros. Conforming to Bu. Ord. configurations with max. error from EZ of 7 minutes.



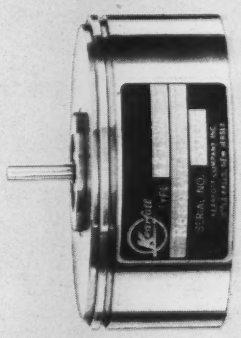
PRECISION RESOLVER (R587)

Size 15. With compensating network and booster amplifier, provides 1:1 transformation ratio, 0° phase shift, 5 minute max. error from EZ.

"PANCAKE" SYNCHROS

2.478 x 1.078 inches, weighs 11 oz. Available as transmitters, control transformers, resolvers, differentials and linear induction potentiometers. Max. error from EZ 2½ minutes. Suitable for gimbal mounting.

All these Kearfott Synchros are constructed of corrosion resistant materials, thus enabling them to be operated under adverse environmental conditions.



ALL PHOTOS 3/4 SIZE

KEARFOTT COMPONENTS INCLUDE:

Gyros, Servo Motors, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Send for bulletin giving data of Counters and other components of interest to you.

KEARFOTT COMPANY, INC., Little Falls, N. J.

Sales and Engineering Offices:
1378 Main Avenue, Clifton, N. J.
Midwest Office:
188 W. Randolph Street, Chicago, Ill.
South Central Office:
6115 Denton Drive, Dallas, Texas
West Coast Office:
253 N. Vinedo Avenue, Pasadena, Calif.

Kearfott

A SUBSIDIARY OF GPE

For more information circle **10** on inquiry card.

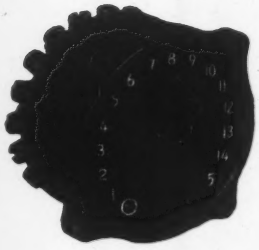
LEWIS SELECTOR SWITCHES
FOR RESISTANCE THERMOMETERS AND THERMOCOUPLE THERMOMETERS

EACH SWITCH HAS "OFF" POSITION PLUS NUMBER OF POINTS LISTED.

Points	Size	Switch Part Numbers: Thermocouple Type	Switch Part Numbers: 3 Wire Resistance-Thermometer Type
2	2″	11S2	36SR2
3	2″	11S3	36SR3
4	2″	11S4	36SR4
5	3″	10S5	37SR5
6	3″	10S6	37SR6
8	3″	10S8	37SR8
9	3″	10S9	37SR9
10	3″	10S10	37SR10
12	3″	10S12	37SR12
16	3″	10S16	37SR16
18	3″	10S18	37SR18
20	3″	10S20	37SR20
24	4″	27S24B2	38SR24
28	4″	27S28B4	38SR28
40	4″	38S2C	

(No. 38S2C is made with soldering-lug terminals)

2" SIZE



3" SIZE

SPECIAL SWITCHES

No. 37S6C2, Four "4 Point and OFF" thermocouple switches combined in one 3″ case.

No. 9S5, Single Pole, Four Point Instrument Switch in 1¼″ round case.

No. 44S4, Six Pole, Double-throw Instrument Switch in 2½″ round case, one hole mounting, ½-32 threaded bushing.

4" SIZE

DESIGNED FOR TEST WORK AS WELL AS FOR PERMANENT INSTALLATIONS. LEWIS SELECTOR SWITCHES ARE CONSTRUCTED WITH STURDY CONTACTS OF LOW RESISTANCE AND POSITIVE DETENT. THESE SWITCHES ARE SPLASHPROOF, DUSTPROOF AND ARE BUILT TO GIVE YEARS OF SERVICE.

THE LEWIS ENGINEERING CO.
Specialists in Electrical Temperature Measurements
NAUGATUCK, CONNECTICUT

For more information circle **11** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

BLS statistics show that productivity has always risen, year after year, since the turn of the century. However, production indexes rise and fall from year to year, with precipitous declines in some periods, as between 1929 and 1933. Conclusion: the automation device must be used when economic, good times or bad times. Also, automation can not affect the economic health of a country directly.

> Industry wide computer sales are now $450 million annually and will increase to more than $1 billion by 1965, says George Trother of GE—upon GE's entry into industrial computer field.

Growth of automation is reflected in the facts that unskilled labor has declined from 12.9% of the total workforce in 1930, to 10.7% in 1940, to 7.8% in 1950 . . . Semiskilled workers have increased from 16.4% in 1930, to 21.0% in 1940, to 22.4% in 1950 . . . . Professionals have increased from 6.1% in 1930 to 6.5% in 1940, to 7.5% in 1950 . . . Clerks and salespersons have increased from 16.3% in 1930, to 17.2% in 1940, to 20.2% in 1950: Note: there are as many professionals today as unskilled labor.

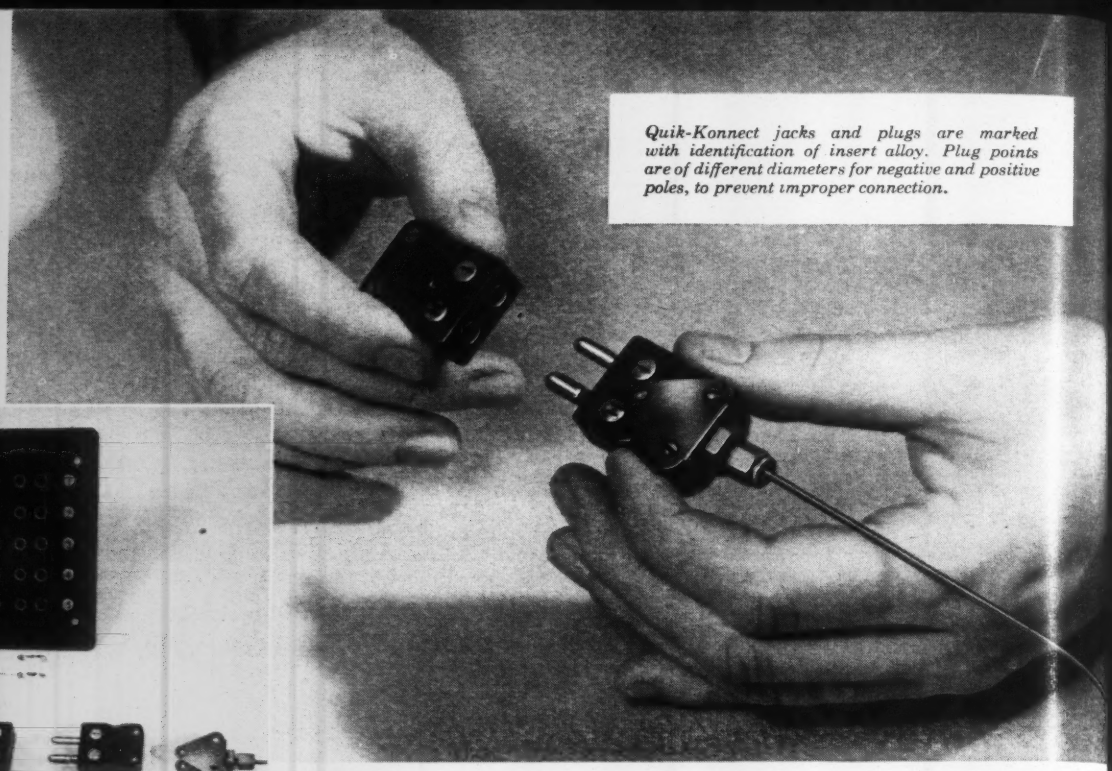
> Interesting new field, made possible by the low-power requirements of transistors, is "powerless" electronic equipment with no power supply. Operating voltages are obtained from solar energy, from r-f signal energy received from transmitters, from a-f energy from audio or voice source.

Survey of first decade of work by the BISRA (British Iron & Steel Research Association) reports on heat conservation in soaking pits; gas turbines for blast-furnace blowing; analysis of working data via punched tape technique; pelletizing and burden preparation for increased productivity; stockline measurements; gas transit time measurements with radioactive tracers; open-hearth furnace instrumentation—furnace pressure, roof temperature, and fuel, air and steam input; strip-mill rolling speed control; notch ductility measurement; new analytical techniques for nitrogen in electrical sheet steel, and oxygen and hydrogen in pure iron; preparation of seven mild-steel spectrographic standards; creep and fatigue measurements; and planned use of a digital computer.

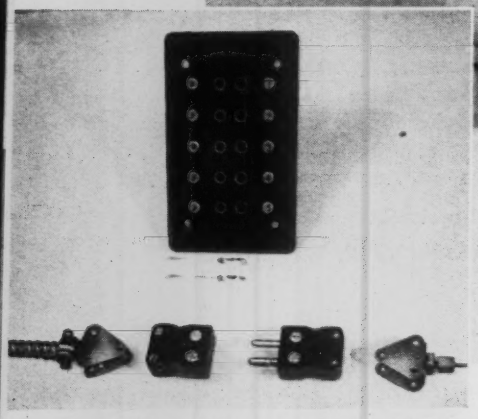
> Annual investment in plant expansion in USA has tripled since 1930—but annual investment in instrumentation has increased ten times. More than 800,000 new productive workers will enter the process industries each year; instrumentation investment alone will be up to $500 per worker.

High-speed photography applications are growing at all phases of research, and development. More than 50 papers were presented at High-Speed Photography Congress in London, September 10-15.

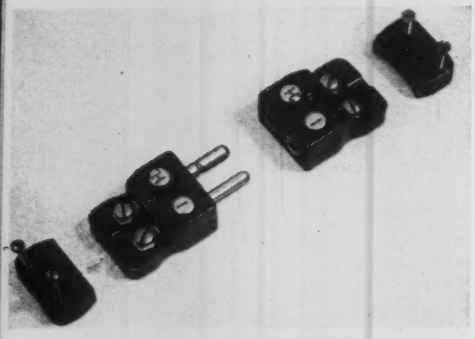
Clinic class (Wollensak) at Automation Exposition, New York, Nov. 26-30, will cover technique of high-speed photography.



Quik-Konnect jacks and plugs are marked with identification of insert alloy. Plug points are of different diameters for negative and positive poles, to prevent improper connection.



The Quik-Konnect Components consist of (left to right) cable clamp, jack, plug, and tube connector, and (above) jack panel.



Only the terminal cover at the rear of the connector need be removed during connection of wires.

Honeywell's new *Quik-Konnect*† Thermocouple Components cut installation time 75%

. . . available through your HSM (HONEYWELL SUPPLIES MAN)

THERMOCOUPLE connection was never so quick and easy! With Honeywell's new *Quik-Konnect* Components you can make single, multiple or selective manual connection of a group of couples to an instrument. No handling of small parts. No confusing snarls of loose wire. Installation and assembly time is cut 75%.

Quik-Konnect Components consist of Fiberglas* filled phenolic plastic plugs, jacks and multiple jack panels with tube connectors and cable clamps for mounting. All assemblies are integral units. You can use these assemblies for quick extension wire connections in a laboratory or test cell, or for convenience and certainty of proper connections in permanent or semi-permanent installations.

Plug and jack assemblies are equipped with inserts or points made from the thermocouple alloys to which they should be connected, and are marked with identification of the thermocouple with which they are to be used. Jack panels, each with five jacks, can be used to connect a number of thermocouples to an instrument, or to group connections at a central location. Panels can be mounted in a control board or conduit box. For complete details, call your nearby HSM (Honeywell Supplies Man). He's as near as your phone; or write for S005-1 specification sheet.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

†Trade name of Minneapolis-Honeywell Regulator Co.
*Trade mark Owens-Corning Fiberglas Corp.

H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

For more information circle 12 on inquiry card.

Inquiries

These inquiries, representing problems facing readers of **Instruments & Automation**, are published as a free service to our readers.

Variable Speed Drive

Engineer in company manufacturing precision devices seeks low-torque transmitting, variable speed drive mechanism (less than one inch-ounce torque). A-157

Automatic Dividing Head

Director of physical science lab in college seeks automatic dividing head which can swivel 180°. Operation may be electric, pneumatic or hydraulic. A-158

Test Air Flowmeter

Test engineer in aircraft company seeks air flowmeter with accuracy better than ± 2% to be used as standard for calibrating other flowmeters. A-159

Strong Permanent Magnet

General manager of chemical specialties company seeks source of supply for inexpensive, strong permanent magnet (about ¼" wide x 1" long) to attach object weighing about one ounce to dashboard of automobiles. A-160

Extra-fine Thread Tools

Purchasing agent in industrial research company seeks sources of supply for screws, nuts, taps and dies for sizes smaller than 0-80. A-161

Variable-frequency Regulated Power Supplies

President of company manufacturing electronic test equipment seeks information on circuits for regulated power supplies with frequency adjustable from 380 to 420 cps, 1% voltage regulation, output adjustable from 90 to 130 volts, 50 to 250 watts. A-162

Cold Cathode Glow Tubes

President of automation products company seeks sources of supply of cold-cathode glow transfer tubes for digital indication. A-163

Geneva Motions

Engineer doing experimental work in manufacturing company seeks suppliers of "Geneva Motions" from stock. A-164

"Multavi" Meter

Manager of research lab seeks identification of German-made "Multavi" meter. A-165

Decals

Instrument maker in University lab seeks suppliers of decals for attaching to research instruments etc. A-166

Surveyor Tables

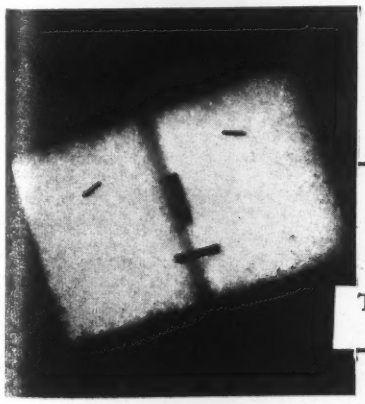
South American importer of precision instruments seeks sources of supply for booklets and tables used by surveyors in conjunction with topographical and geodetical instruments, in particular on planimetry, altimetry, also tachometrical tables of sexagesimal division, and reducing tables for horizon calculations. A-167

Electric Counter

Manufacturer of motors, fans, etc., seeks an electric counter with a solenoid for each digit; should he wish to count to 845 he would send 8 impulses to the 100, 4 impulses to the 10, and 5 impulses to the unit solenoid. Difficulty is that as the unit line moves from 9 into 0, it has to move the tens digit because of the decimal add, and at the same time the 10 unit line may be moved by an impulse which it is receiving. A-168

Check Weighing

Fertilizer manufacturer seeks check weighing equipment for weighing 100¼ lb. bags of fertilizer to a tolerance of ±¼ lb. Rate of weighing to be not less than 15 bags per minute. At high or low limit an audible and visual signal must be given, also the bagging machine and bag conveyor must stop. A-169



WORRIED ABOUT PRECISION PIVOTS?

Call VK

Steel, chromium plated, or carbide precision pivots to .013" diameter. 1 RMS or finer surface finish. Diameter tolerances to .000010". Chamfers, radii, lapped ends, etc.

Also volume production lapping of flat or round production parts.

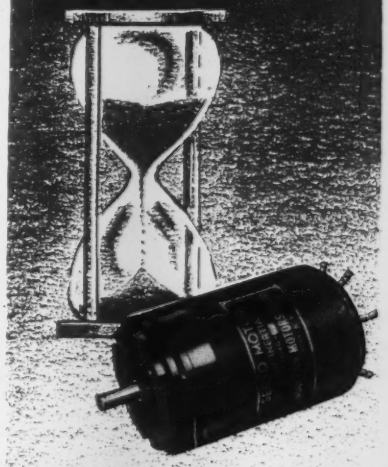
Submit your specifications

THE VAN KEUREN COMPANY
176-A WALTHAM STREET
WATERTOWN, MASS.

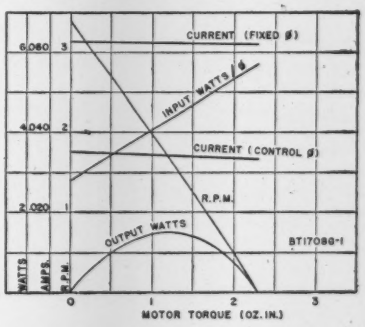
The photographer's nightmare at the left consists of a lump of sugar and four VK Precision Pivots. The "eyes" are .080" long.

For more information circle **13** on inquiry card.

engineered for longer life...



If longer life is a primary requirement in your control or system application, specify the BT 1708 G-1 or any of the other servo motors made by INDUCTION MOTORS CORP. These units are built to JAN and MIL specifications, surpassing all standards for performance in extreme conditions of humidity, temperature, vibration or altitude.



SPECIFICATIONS • BT 1708 G-1

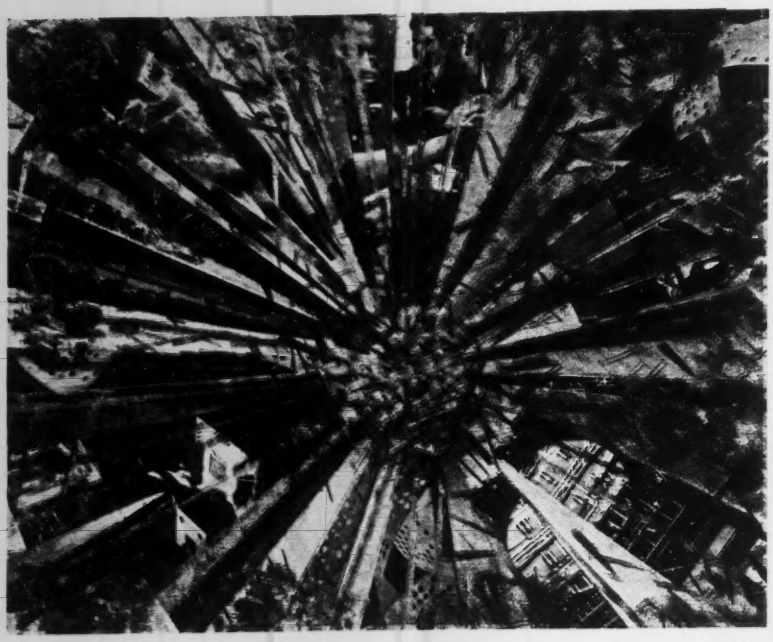
Two phase • Reson. Imp. 9000 ohms
60 cycles • Two pole • 3300 free rpm
Voltage-Reference winding: 115 volts
Voltage-Controlled winding: 230 volts
Weight: 1 lb.

In addition to servo motors, IMC offers a full line of AC and DC subfractional and gear motors, fans, blowers and dynamotors. Discuss your motor design and application problems with us.

Induction Motors Corp.

570 Main St., Westbury, L. I., N. Y.
EDgewood 4-7070

For more information circle **14** on inquiry card.



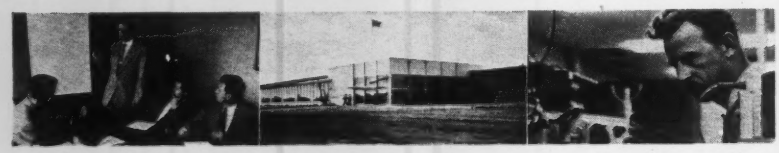
OPPORTUNITY IN SOUTHERN CALIFORNIA

stable, high-paying careers for

CREATIVE DIGITAL COMPUTER ENGINEERS

experienced in advanced data-processing systems design

Here, in one of America's leading companies in the development of digital computers and electronic systems, you'll have full opportunity to make design contributions at the most advanced level. You'll enjoy the broad working freedom of a small, select research-design group and the vast technical resources of a parent company of international stature. The program is a continuing one with constant creative challenges. Because most activity is in development of equipment for worldwide commercial markets, stability is assured. Related projects are also undertaken for government and industry. New, ultra-modern, air-conditioned facility in a pleasant suburb of Los Angeles—the nation's fast-growing electronics capital. Broad benefits.



Senior Mechanisms Engineer Must be a strongly creative man with demonstrated ability in computer input-output devices.	**Senior Electronic Engineer** With experience in drum memories for digital computer systems. Excellent opportunity to form and head project in this work.
Senior Computer Circuitry Engineer With transistor experience in digital computer applications. Core circuitry experience desirable.	**Senior Mechanical Engineer** A key job requiring two or more years' mechanical design experience in high-speed digital magnetic tape handling units.

Excellent openings for engineers with experience in: logical design · ferroelectrics · magnetic cores · computer systems · transistor circuits · input-output devices · applications of physics · computer systems specifications · definition of system requirements.

For 16-page brochure describing activities and career potential at the NCR Electronics Division, write or contact D. P. Gillespie, Director of Industrial Relations

National*

*Trademark Reg. U. S. Pat. Off.

THE NATIONAL CASH REGISTER COMPANY
Electronics Division
1401 East El Segundo Boulevard, Hawthorne, Calif.

INSTRUMENTS and AUTOMATION

November 26-30
Third International Automation Exposition, New York Trade Show Building, 500 8th Ave., New York, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

November 28-29
National Simulation Council Meeting, New York Trade Show Bldg., N. Y. See details on page 2245.

December 5-7
Second IRE Instrumentation Conference & Exhibit, Biltmore Hotel, Atlanta, Ga. Sponsored by Professional Group on Instrumentation and the Atlanta Section of the IRE. For information write M. David Prince, Engineering Experiment Station, Georgia Inst. of Technology, Atlanta, Ga.

December 6-8
The first Southwide Chemical Conference sponsored by the Southeastern and Southwestern Regions of the American Chemical Society with the cooperation of the Memphis Section of the Instrument Society of America, Memphis, Tenn. For information write Southwide Chemical Conference, 2899 Jackson Ave., Memphis 8, Tenn.

December 9-12
49th Annual Meeting of American Institute of Chemical Engineers, Hotel Statler, Boston, Mass.

December 10-12
Eastern Joint Computer Conference, Hotel New Yorker, New York City. For information write A. Forman, Rm. 639, 480 Lexington Ave., New York 17, N. Y.

December 19-20
Applied Reliability Symposium, Radio-Electronics-Television Manufacturers Association, Bovard Hall, University of Southern Calif., Los Angeles. For information write RETMA Engineering Office, Room 650, 11 W. 42nd St., New York 36, N. Y.

January 14-16, 1957
Third National Symposium on Reliability and Quality Control in Electronics, Hotel Statler, Washington, D. C. For information write R. C. Murrell, Melpar, Inc., Falls Church, Va.

January 23-25
Symposium on "Theoretical and Experimental Results in the Propagation and Radiation of Very-Low-Fre-

Events

quency Electromagnetic Waves (less than about 100 kc), "NBS Boulder Labs., Boulder, Colo.

January 28-31

Plant Maintenance and Engineering Show, Public Auditorium, Cleveland. For information write Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

February 14-15

1957 Transistor and Solid State Circuits Conference, Univ. of Pennsylvania, Phila., Pa. Sponsored by IRE and AIEE.

February 19

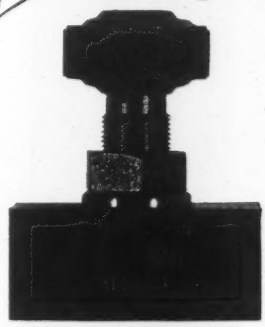
13th Annual Quality Control Clinic. Sponsored by Rochester Society for Quality Control, War Memorial, Rochester, N. Y.

February 26-28

1957 Western Joint Computer Conference, Statler Hotel, Los Angeles, Calif.

ROBBINS

Leakproof Metering Valves



- Hi Vacuum to 6000 PSI.
- "O" Rings and Teflon or Nylon Seats are standard.
- Over-torquing cannot damage seat or needle as buffer plate and metering pin act as a forming die.
- Impossible to score needle or seat.
- Lifetime Valve—can be completely overhauled in a matter of minutes without disturbing plumbing or mounting.
- The most economical valve in the long run.

Write for further details.

ROBBINS AVIATION

1735 W. Florence Ave.
Los Angeles 47, Calif.

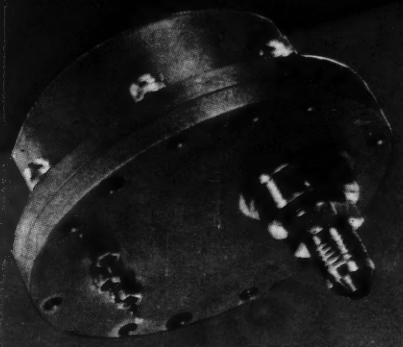
For more information circle **16** on inquiry card.

PRESSURE TRANSDUCERS

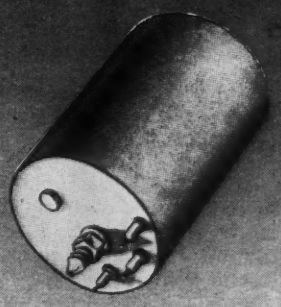
designed specifically

for VANGUARD

EARTH SATELLITE VEHICLE

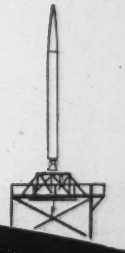


RAHM



For use with Nitric Acids, 90% Hydrogen Peroxide, UDMH, and other corrosive fuels and oxidants; at temperatures up to 500°F.

These instruments are available in ranges from 10 PSI to 2500 PSI, in absolute or differential configurations.

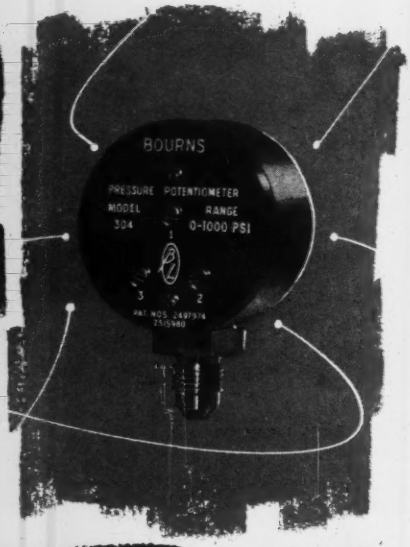


RAHM INSTRUMENTS INC.

237 Lafayette Street, New York 12, N. Y.

For more information circle **17** on inquiry card.

BOURNS



MODEL 304

GAGE PRESSURE TRANSDUCER

—high performance in miniature size

Only 1⅝" in diameter... ¾" thick, this is an exceptionally small gage pressure potentiometer. Its miniature size and compact configuration permits use in ground and airborne installations—in control telemetering or remote recording circuits—wherever space is at a premium.

Time proved performance. This is a fully integrated instrument built for high reliability under extreme environmental conditions. The dependable Bourns Bourdon tube assembly and linkage system provide exceptional shock, vibration and acceleration characteristics ... linearity and hysteresis are excellent. Units are designed to meet or exceed most government specifications for airborne equipment.

The Bourns Model 304 weighs about 2 ounces. It operates with a high-level AC or DC signal. Pressure ranges: from 0-100 to 0-5000 psi. Three Bourdon tube materials are available:

Beryllium copper—the standard construction—for non-corrosive fluids. Measures air, Freon, oil, and other common media.

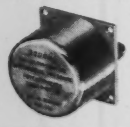
Stainless steel—permits corrosive fluids such as fuming nitric acid to be applied within the tube.

Ni-Span-C—provides low temperature error for versatility of application.

Complete data in Bulletin No. 304.

ABSOLUTE AND DIFFERENTIAL PRESSURE

In addition to the Model 304, Bourns manufactures a complete line of high pressure transducers in absolute and differential ranges, for use with corrosive or non-corrosive fluids. Request Bulletin No. 70456.



MODEL 704—differential pressure type with stainless steel Bourdon tube

MODEL 706—differential pressure type with Beryllium copper Bourdon tube

MODEL 705—absolute pressure type for use with clean, non-corrosive media

COPR. BL

BOURNS LABORATORIES

General Offices: 6135 Magnolia Avenue Riverside, California
Plants: Riverside, California—Ames, Iowa

For more information circle **18** on inquiry card.

EVENTS—CONTINUED

March 4-8
Eighth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Penn-Sheraton Hotel, Pittsburgh, Pa.

March 5-8
1957 Conference on High-Speed Computers, Louisiana State University, Baton Rouge, La. For information write Frank T. Carroll, Jr., College of Engineering.

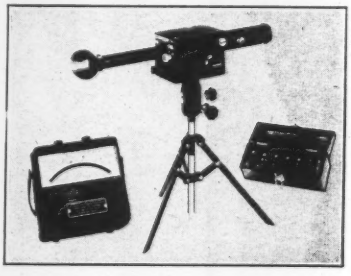
March 11-14
The IRE Professional Group on Nuclear Science is cooperating with the EJC Second Annual Nuclear Science and Engineering Congress in Philadelphia. For information write Dr. Sidney Krasik, Editor, IRE—PGNS Transactions, 5621 Wilkins Ave., Pittsburgh 17, Pa.

April 7-12
131st National Meeting, American Chemical Society, Miami, Fla.

April 11-13
Nine Southwestern I.R.E. Conference and Electronics Show, Shamrock Hotel, Houston, Texas.

April 22-24
IRD's 3rd Annual Conference on Control System Applications, Northwestern Univ., Evanston, Ill.

PYRO — FOR PRECISION TEMPERATURE MEASUREMENTS



NEW! PYRO Micro-Optical Pyrometer

The most versatile optical pyrometer ever designed—unsurpassed in accuracy and ease of operation. Adjusts to focal lengths of 5 inches to infinity and has table-top and floor style mountings with vernier adjustments for telescope sighting. Readily measures targets .001" in diameter. Temperature scales 700-3200°C (1300-5800°F). Write for free Catalog No. 95

THE PYROMETER INSTRUMENT CO.

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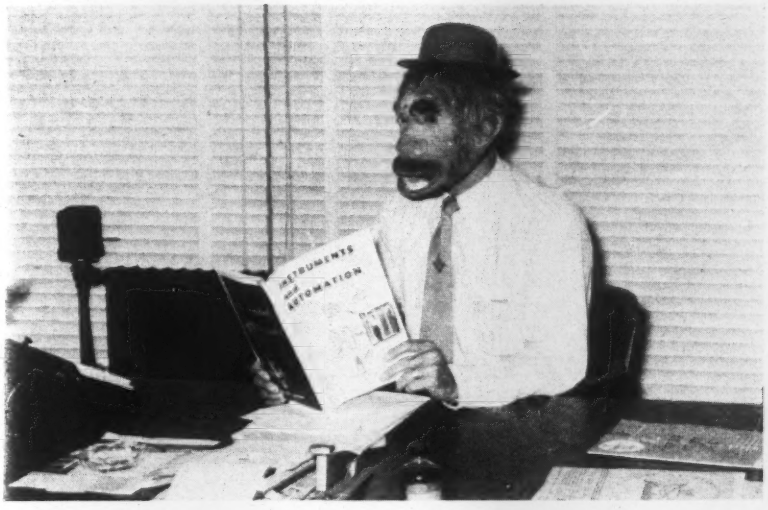
Manufacturers of PYRO Optical, Radiation, Immersion and Surface Pyrometers for over 25 years.

For more information circle **19** on inquiry card.

D.R. of the Month - - -

Panhandle Pete



Do you faithful readers of this magazine ever wonder who this "D. R." person is to whom our forceful Editor, M.H.A., is always writing and prodding along? Did you ever wonder what type of personality and level of inteligence the "D. R." has? Have you ever pictured an individual who could understand all of the articles in any given volume of I & A? Have you ever wanted to meet a famous man—the only one in our history to receive $50.00 for information leading to the arrest and conviction of anyone stealing a speaker at a drive-in theater? Well this month I wish to introduce to you such a distinguished man: Mr. Waldo Klapsaddle, Jr., of Long Bottom, West Virginia, the "D. R." of the month!

Mr. Klapsaddle is Branch Manager of the Wallace Electronic Supply Co., manufacturers of that well-known gas analyzer, *The Aves*. While not a member of the ISA, PTA or BSA he is also not a member of AISE, AIEE or ASME. He has not been president, secretary or treasurer of these societies nor has he ever made any after-dinner speeches, served on committees or made any other contributions, being smarter in some ways than the rest of us.

As you can see from this photo of Waldo, taken in the privacy of his office, he is intently interested in reading his copy of *Instruments and Automation*. As he wrote in answer to the request for information on this story, "Dear Cuz, (Waldo calls everybody "cousin") I can't hardly wait for this here magazine to get here so I can read it becaws I know by tomorrow the world is going to be run with insterments and I want to be prepared for these big money jobs. I espeshly like to read the Stimu . . . Sumu . . . Stipa . . . Oh hell, I can't spell it—letter on Komputters and things like that there. Do you think I can get a job. Huh? I reckon you can see the digital Komputter on my desk? Ain't it pretty? I looked up digital in the dicksionary and it says it means "Of the fingers or digits." I knowed all along Mr. Aronson was only kidding when he was trying to make me believe all this other— —in his magazine. And you ought to see the dandy autermatic control I got on my radiator! When I want some heat I just turn that little crank on the side of the box until the valve is open and then when it gets too hot I turn the little crank until the valve is all the way shut. I never knowed what all the pretty wire was for but the other little box that came at the same time has a mighty nice little thermometer on it and I hung it out on the back porch for the old woman to look at."

I am pleased to acknowledge Waldo's tremendous contributions, not to his society nor to any field of process instrumentation. His biography is a mess but it shows that everybody sets out to do something, and everybody does something, but nobody does what he sets out to do.

Waldo Klapsaddle, Jr. was born. At an early age his parents moved to McKeesport, McKees Rocks, Aliquippa, Vanport, Wellsville, Wellsburg, Bellair and Ben's Run, W. Va., one step ahead of the sheriff and two steps behind Waldo. (Even his parents were ashamed of him.) Finally they succeeded in abandoning Waldo on a ferryboat between Long Bottom and North Long Bottom, and kindly neighbors, taking pity on the little monster, raised him up to the handsome and intelligent man you see in the photo. (My gawd, look at the head on that thing!) His schooling started in the sand-box and willow trees along the Ohio River, and progressed through grade and high school where he was graduated with highest honors (Waldo is 6′-5″) and promptly married his English teacher at age 50. Since then he has been associated with Project Tinkertoy (the wooden ones) and is now working on his Masters Degree from The Gilbert Hall of Science.

For many years, Waldo was in complete charge of one of the largest chemical plants in the Ohio Valley, on night turn. I mean you read in the newspapers about all the industry moving into this area but who are DuPont, Mathieson or Pittsburgh Coal in comparison with the Amalgamated Ridge-Runners Whiskey Association, producers of that rare exotic blend 'Old Factory Whistle—One toot and you're done'? After the T-men visited the plant one evening and found Waldo sampling the product they hustled him into the county seat before a judge. Here, at his trial, he was distinguished for his ignorance; he had only one idea and that one was wrong. As manager of *the* key industry in Long Bottom, Waldo is much in demand as a public figure. (The latest offer came from Goodings Shows who wanted him to manage the side-show—or was it to be *in* the side-show?)

Waldo says "I have been reading *Instruments and Automation* for a long time. I even remember when Major Behar was only a private; whatever happened to him? Your fine magazine has proved very beneficial to the entire management of the factory not only through the nice pictures but also because the paper makes real good parts for our gas analyzers as disposable Base-Liners."

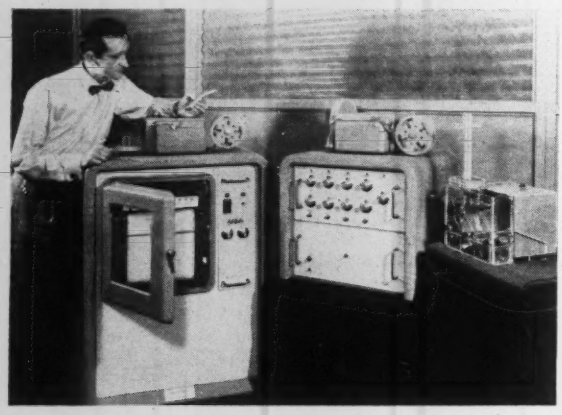
Panhandle Pete

INSTRUMENTS and AUTOMATION News

Principles & Applications 2152 to 2164
Stock Report 2166
New Plants & Mergers ....2169 to 2170
People in the News .....2173 to 2174

Integrated Test System

LOS ANGELES, CALIF.—An integrated automatic test and inspection system for the evaluation of a wide variety of electronic components and other products has been developed by Electronic Control Systems, Inc., of Los Angeles, an affiliate of Stromberg-Carlson, and a subsidiary of General Dynamics Corporation.



This new system automatically transports, tests, and physically sorts (for quality) components such as semiconductor diodes, and, in addition, keeps records on punched paper tape. It also automatically assembles overall quality statistics. The complete system consists of five basic elements: Automatic hopper feed mechanism, automatic sorter, automatic tester and recorder, automatic analyzer, and a keyboard input to the automatic analyzer.

It will be exhibited to the public for the first time at the Third International Automation Exposition in New York, Nov. 26-30.

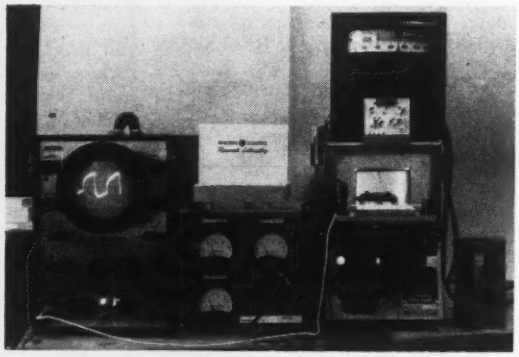
Card-Programmed Mill

PITTSBURGH, PA.—A new reversing roughing mill now being completed for Jones and Laughlin Steel Corporation's Aliquippa Works is expected to be the steel industry's first completely automatic card-programmed rolling mill. "Prodac," (programmed digital automatic control) developed by Westinghouse, will permit an operator to initiate a detailed rolling schedule simply by pressing a push button. By selecting the proper IBM card from several pre-punched for each schedule, it will be possible to attain a definite set of reductions while allowing for variations in temperature and composition among individual slabs.

Each card will include all the requirements of a given schedule: mill screw-down opening, edger adjustment opening mill speed, and edger speed. After the card is read by an IBM card reader all information is transferred to a transistorized memory storage element. The control equipment acts through magnetic amplifier output units to preset roll openings and speeds. When the final pass is completed, an indicator light automatically signals the operator at the crop shear that the strip is ready to enter the finishing mill.

Penetrating The Thermal Barrier

NEW YORK, N. Y.—The tremendous heat created by air friction when an object travels at extreme speeds, or to be withstood when it is exposed to intense nuclear radiation in an atomic reactor, has prompted extensive research in this direction.



To demonstrate the progress made, General Electric Co. recently held a press conference in which electronic components and circuits were described and demonstrated which operate at high temperatures ranging from 900 to 1500°F and for thousands of hours without adverse effects.

Projects like the intercontinental guided missile, the satellite, and supersonic plane, have received a new impetus from the research work. Although conventional vacuum tubes, resistors, capacitors and print boards disintegrate quickly when exposed to temperatures from 300 to 600°F, the demonstrations proved that components are available to operate at temperature conditions two and three times as high.

Eight departments of GE in as many different locations cooperated in the program. The illustration shows a multivibrator circuit operating in an oven at 700°C.

Test-Stand Test Stand

SANTA MONICA, CALIF.—Lear Aircraft Engineering Division, Santa Monica, Calif., has delivered to Rocketdyne Division of North American Aviation a substantial

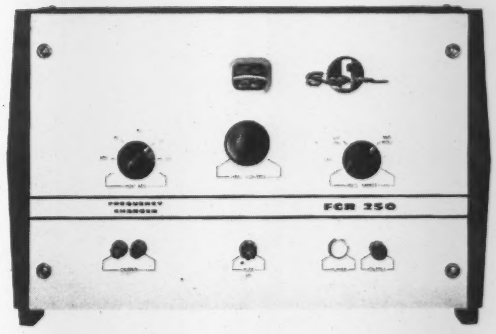
NOW-PORTABLE
400 cycle power

This new frequency changer makes it possible to provide well regulated 400 cycle power conveniently and quickly. This unit, Model FCR 250, is extremely useful in a wide variety of applications including testing, production, airborne frequency control, computers, missile guidance system testing, and in practically any application where the use of 400 cycle power is advantageous.

Model FCR 250 is only one of a complete line of frequency changers available from Sorensen . . . the authority on controlled power for research and industry. Write for complete information.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1 phase, 50-65 cycles
Output voltage	115 VAC, adjustable 105-125V
Output Frequency	320-1000 cps in two ranges
Voltage regulation	±1%
Frequency regulation	±1% (±0.01% with auxiliary frequency standard fixed at 400 cycles)
Load range	0-250 VA



MODEL FCR 250

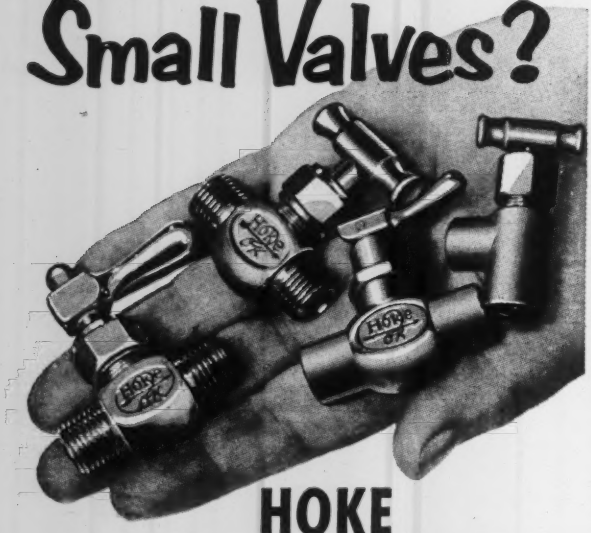
SORENSEN & COMPANY, INC. Sorensen STAMFORD • CONN.

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment.

For more information circle **20** on inquiry card.

NEED

Small Valves?



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FLUID CONTROL SPECIALISTS

can solve your problem with all types and sizes

- **Standard Types** • **Special Designs**

for high vacuum conditions, high pressure conditions, and corrosive fluids

TEST & LABORATORY EQUIPMENT Needle valves with chrome or nickel finish; quick-opening valves for stopcock service; ball-type check valves in brass and stainless steel; high vacuum valves in toggle style, packless and needle types.

CORROSIVE FLUIDS Needle valves and toggle valves in several types of stainless steel; needle valves made from other alloys; aluminum, Monel, carbon steel; packless valves of diaphragm and bellows types in several alloys.

INSTRUMENT AIR LINES Needle valves for direct panel mounting; toggle valves for on-off service with colored plastic handles for quick identification; valves for use with tube fittings.

SPECIAL DESIGNS In many cases, our engineers can adapt standard valves to equipment manufacturers' special requirements.

Write for the Hoke Catalog

This completely illustrated 68 page catalog contains specifications on needle valves of all sizes as well as toggle valves, packless valves, special purpose valves, fittings and accessories. Tell us about your problem and we will gladly send you a copy of the catalog with our specific recommendations.

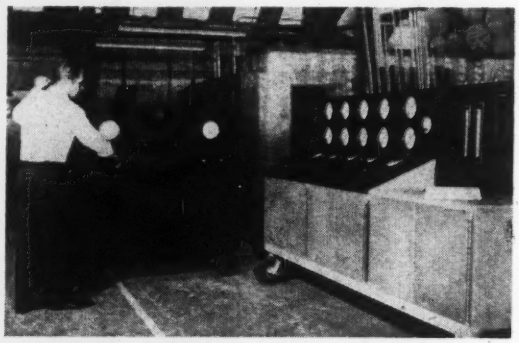
HOKE

HOKE INCORPORATED

Fluid Control Specialists

231 S. DEAN STREET, ENGLEWOOD, N. J.

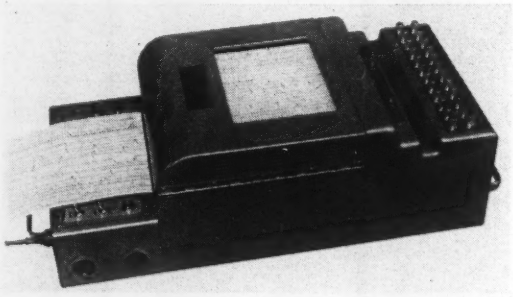
For more information circle **21** on inquiry card.



number of mobile pneumatic and electrical test stands (right) for checking out rocket engines without actually firing the engines. The complexity and high performance characteristics of the rocket engine test stands required Lear's design and construction of a good-sized auxiliary test stand (left) to check them out.

Oscillography-Xerography

ROCHESTER, N. Y.—Oscillography (trace recording) and xerography (dry reproduction process owned by The Haloid Company) are used in a new recorder.



Century Electronics and Instruments, Inc. has developed an oscillograph employing xerographic principles which can be used, for example, in taking test data around atomic installations where exposure to radiation will not allow normal photographic means to be employed.

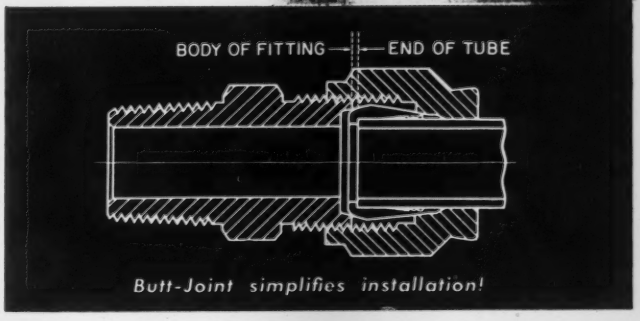
Inertial Guidance Systems for Satellite

MINNEAPOLIS, MINN.—Details on the guiding systems for the Project Vanguard rockets now have been divulged. The guidance reference system, entirely rocket-borne, will keep the finless rocket from swerving off course and gradually "tip" the rocket's trajectory so that it enters a globe-circling course some 300 miles above earth.

Heart of the controls system are three highly-accurate Honeywell electronic gyroscopes (hermetic-integrating) that will be calibrated to a "memorized" heading reference in the three axes or directions of flight—roll, pitch and yaw. They require bearings alike to within 10 millionths of an inch.

If the rocket incorrectly rotates—because of sloshing fuel, engine irregularity, etc.—even an infinitesimal part of a degree, the gyro motors will respond by rotating the gimbal on its jeweled bearings. This movement is

the most important advance in tube fittings in 20 years!



New IMPERIAL HI-SEAL™

Furnished in steel and stainless steel

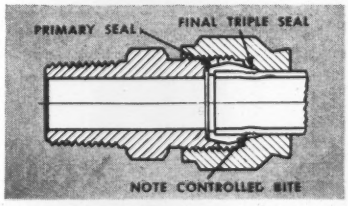
makes a positive butt-joint • no need to spring tubing • withstands higher pressures • foolproof assembly • no flaring or threading

Hi-Seal is the successor to all present tube fittings for high-pressure, severe service. Never before such ease in making a truly foolproof tubing connection. Sleeve fits only *one* way, cannot be installed in reverse — no chance for error. Positive butt-joint with no tube entry into body of fitting eliminates need to spring tubing. This is especially important when working with large-diameter, heavy-wall or hard-temper tubing. Positively no torquing of tube when making a joint!

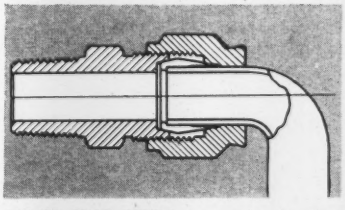
All this plus the fact that Hi-Seal fittings can be disconnected and reconnected as often as desired with assurance of original pressure-tight seal!

Conforms to **J.I.C.** Standards

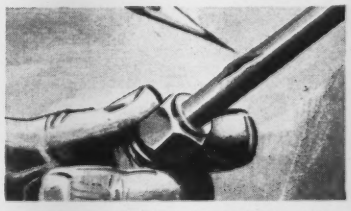
Ask your Imperial distributor for full details on the Hi-Seal Fitting. Write for Bulletin 3061.



FOOLPROOF ASSEMBLY — Hi-Seal goes together only one way. No need to disassemble or double check for tightness.



CLOSER TUBE BENDS — works in close quarters where other types of fittings cannot be used. A real aid to design.



WITHSTANDS HIGHER PRESSURES — Joints stay tight beyond the burst pressure of the tube . . thoroughly field tested.

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Industry's most complete line of tube fittings and tubing tools.

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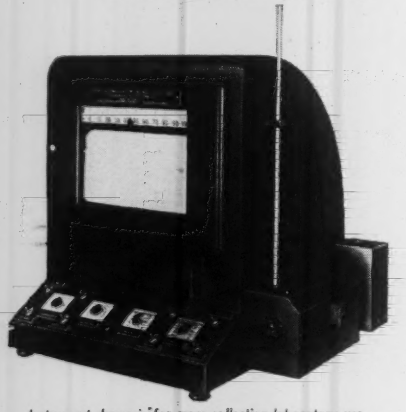
MEASURE AND RECORD THE DIFFERENCE

in refractive index in non-opaque liquid streams with the

NEW PHOENIX

automatic recording differential refractometer



Instrument shown is for mass-collection laboratory use. Other models available for process use. Limiting sensitivity 3 x 10^{-6}.

With this new precision instrument, you can plot refractive index changes in any non-opaque liquid stream, such as distillate or a chromotographic eluate.

The new Phoenix Automatic Recording Differential Refractometer makes possible extremely accurate qualitative and quantitative analysis of hydrocarbons, alkaloids, steroids, antibiotics, rare earths and other materials. It thus can facilitate accurate process control in chemical, petroleum, pharmaceutical, and many related industries.

Several models available for laboratory, process applications. Even the most sensitive has a 6600-unit range, without the necessity of changing cells or reference solutions.

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Please send complete information on your new Automatic Recording Differential Refractometer for:

☐ measurement and recording in laboratory use.
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Company_____

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City_____

State_____

For more information circle **23** on inquiry card.

sensed by the gyro signal pickoff and sent out as an electrical signal from the gyro through the autopilot amplifier to the error-correcting servo system. The HIG-6 gyro used in the Vanguard rocket application is specially made for the system, because—unlike true inertial-type guidance systems—the Vanguard system is "strapped down" to the rocket. Thus the gyro was too sensitive for the application—like an automobile steering wheel with insufficient "play"—and the gyroscopic engineers had to cut down the size of the gyro wheel.

An HIG can measure the rate at which a glacier melts, or motion 3,000 times slower than the hour hand on a watch. HIG gyros are in production at Minneapolis-Honeywell's Aeronautical Division. About 19,000 of these ultra-precise HIG's have been produced for various applications. The gyro unit will be mounted on Robinson mounts.

New 100,000-megacycle Electron Tube

BALTIMORE, MD.—The Air Research and Development Command has made public a "retarding field oscillator," which works well at a frequency of 70,000 megacycles with large power output and, with reduced power output, at 100,000 megacycles. It was developed at Ohio State University for the ARDC and is considered one of the most significant research contributions in the field of electronics in recent years.

Statement of Ownership, etc.

Statement of the Ownership, Management, Circulation, Required by the Act of Congress of August 24, 1912 as amended by the Acts of March 3, 1933 and July 2, 1946 (Title 39, United States Code, Section 233) of

Instruments and Automation

published monthly at Pontiac, Illinois, for October 1, 1956.

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Richard Rimbach, Pittsburgh, Pa.; Editor, Milton Aronson, Pittsburgh, Pa.; Managing Editor, Fred D. Marton, Pittsburgh, Pa.; Business Manager, Richard Rimbach, Pittsburgh, Pa.

2. The owner is: (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one percent or more of the total amount of stock.)

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M. F. Behar, Pittsburgh, Pa.; M. D. Pugh, Altadena, Calif.; Martha B. Rimbach, Allison Park, Pa.; Richard Rimbach, Pittsburgh, Pa.; Richard J. Rimbach, Jr., Pittsburgh, Pa.

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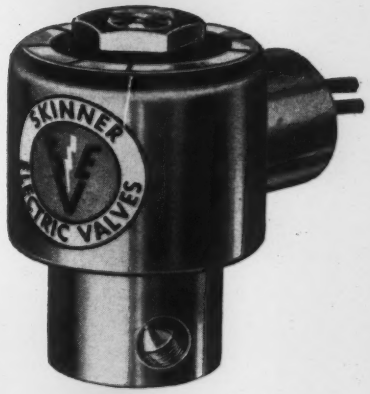
4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Richard Rimbach, Publisher

Sworn to and subscribed before me this 24th day of September, 1956. Kenneth M. Winterbottom Notary Public. My commission Expires December 11, 1959.



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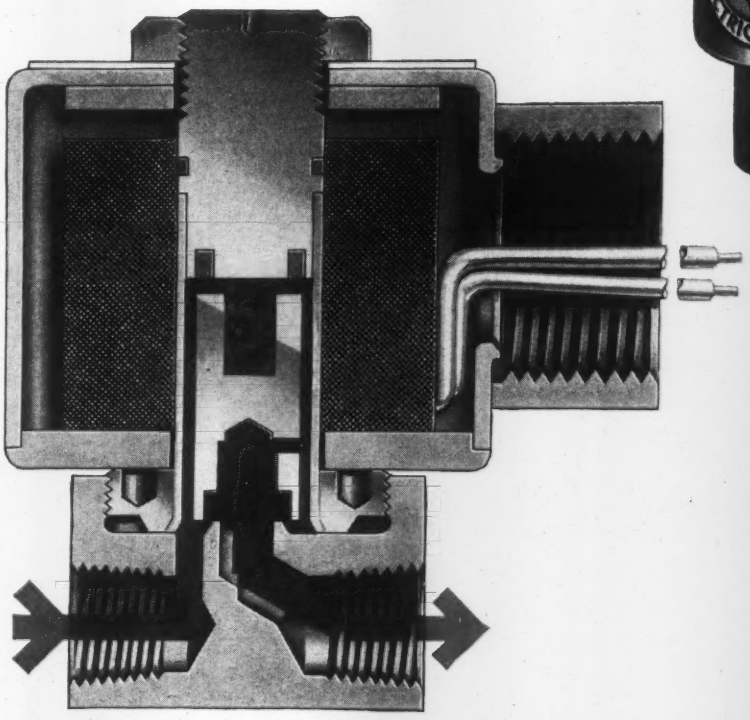


New C-series solenoid valve offers recognized "Skinner Quality" at low cost

This is a faithful reproduction – in miniature – of the time-tested, 2-way, normally closed Skinner V5 except that the body is made of brass.

This new, compact Skinner valve weighs only 12 ounces, yet it's rugged enough to last millions of cycles on most applications. It is a packless, direct-acting valve with only two moving parts. And it's absolutely bubbletight – even on vacuum. This C-Series Skinner valve is failproof, too – positive closing is assured by a spring return. It can be mounted in any position and is ideal for direct-line mounting.

You'll find this new valve, with its recognized "Skinner Quality," the perfect low-cost answer to a wide range of flow control problems. It works efficiently with air, water, oils, gasoline and many other media. Typical applications include: automotive fuel systems, welding equipment, vending machines, lubricating devices, spraying equipment, air horns, water softeners, humidifiers and instrumentation.

Our Bulletin D11.1 contains complete information on this valve – flow curves, optional features, dimensions, electrical data, etc. We will be happy to send you a copy on request.

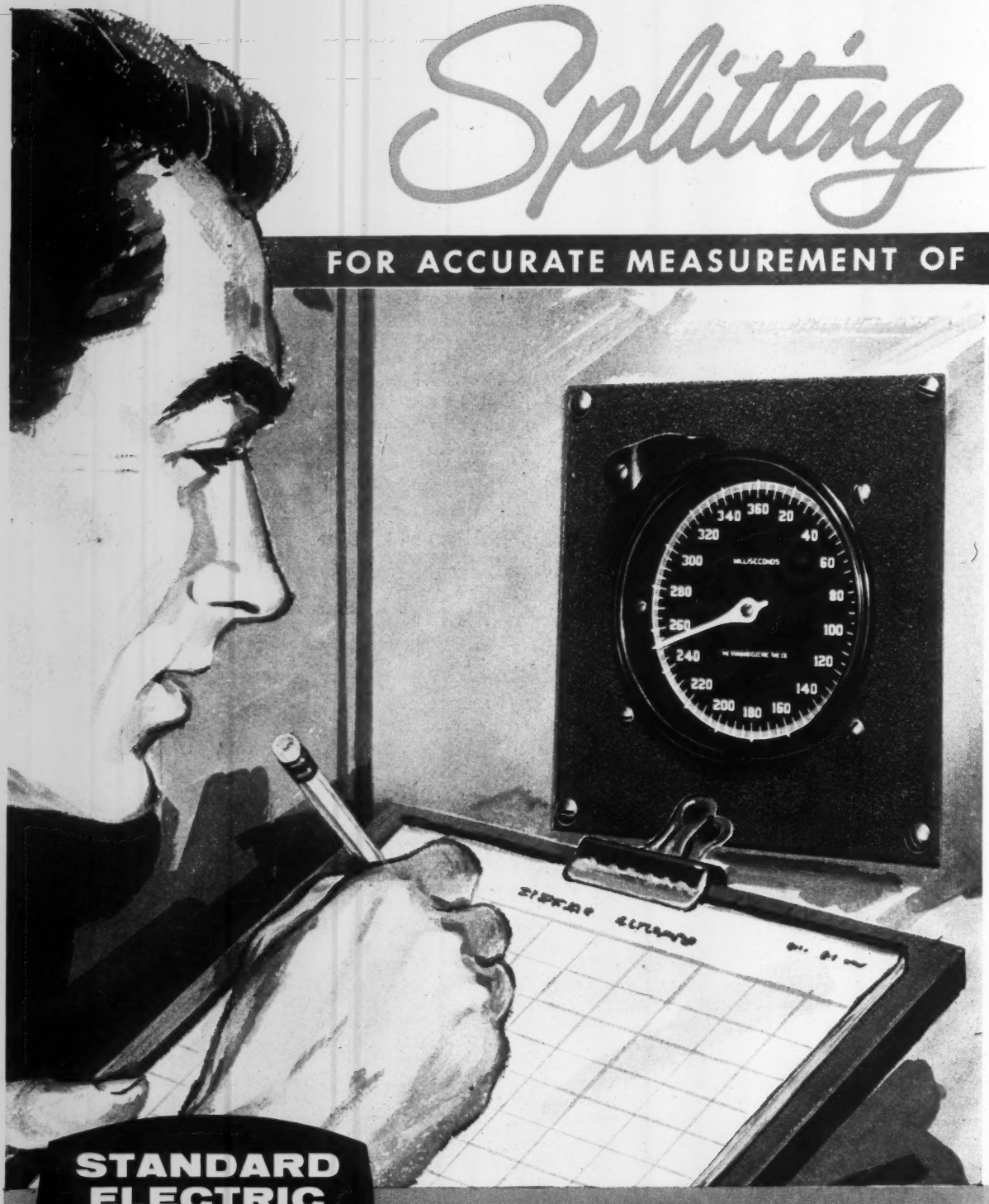
SKINNER ELECTRIC VALVES

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
THE SKINNER CHUCK COMPANY

For more information circle **24** on inquiry card.

Splitting

FOR ACCURATE MEASUREMENT OF



STANDARD ELECTRIC TIME COMPANY
Springfield 2, Massachusetts

SINCE 1884

THE STANDARD PRECISION TIMER
is the indispensable STOP Watch in laboratory and test cell, on experimental nuclear projects, precision production, check and final inspection. Many important applications in almost every industrial plant and research laboratory.

For more information circle **25** on inquiry card.

Split Seconds

ELAPSED TIME . . . AS CLOSE AS 0.001 OF A SECOND

PRACTICALLY ALL Representative Manufacturing, Processing and Research Plants *USE* STANDARD PRECISION TIMERS

At one of the world's largest automotive manufacturers — timing test action in automatic transmission research.

It is our frank belief that literally hundreds of concerns have not yet scratched the surface of usefulness to which Standard Precision Timers can be put to work in their plants.

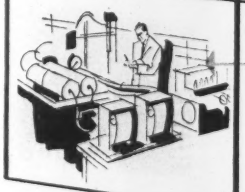
For Glenn L. Martin Co.'s Gunnery Trainer — in 12-channel Playback System designed by Cook Research Laboratories.

At Eastman Kodak Co. — timing photo cell controlled exposures in automatic photo printing machine.

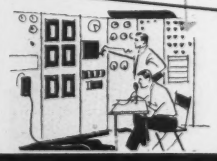
At Yucca Pass, Nevada Proving Grounds — helping maintain split-second control of atomic bomb tests.

At General Electric Co. — Trumbull Division — measuring operating time of circuit breakers.

In Bell Telephone offices throughout the U. S. — timing elements required to complete telephone connections.



At Bendix — Westinghouse Research Dept. laboratories — measuring brake application and release time to 1/100th of a second.



At American Brass Co. — indicating metallurgical analysis in Direct Reading Spectroscope developed by Baird Associates.

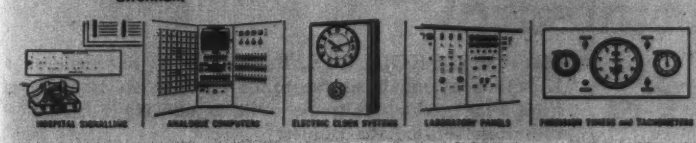
Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

World's most accurate and rugged time measuring instrument. Built in many different and advanced designs to meet practically every need of precision time measurement. Requires minimum maintenance.

Synchronous motor drive. Electric clutch controlled by manual switch, automatic switch or output of electronic tubes. Manual or electric zero reset.

SEND TODAY for Bulletin #198 describing entire line with partial list of thousands of customers, and summary of some of the most frequent (and some of the most unusual) ways they use STANDARD ELECTRIC TIMERS.

We suggest you check your requirements for Standard Timers and other products today. Your order or inquiry will receive prompt attention.



The STANDARD ELECTRIC TIME Co.
93 Logan St., Springfield 2, Mass.

Please send Bulletin 198 describing your line of instruments for measuring elapsed time as close as 0.001 seconds.

Name.....*Title*.....

Firm.....

Address.....

.....

For more information circle **25** on inquiry card.

automation

ENGINEERS SCIENTISTS

New York Interviews by Leeds & Northrup Company at The International Automation Exposition

NOVEMBER 27-30

If you enjoy doing creative work in

- **NUCLEAR INSTRUMENTATION**
- **STEAM AND POWER PLANT CONTROL**
- **AUTOMATIC COMPUTERS**
- **INDUSTRIAL PROCESS CONTROL**
- **ANALYTICAL INSTRUMENTATION**

then consider an organization which has been a pioneer and leader in instrumentation for over 50 years. Join a growing Company in an expanding industry.

We have openings in

—sales engineering
—market development
—research
—development
—service
—application engineering
—production engineering

Interviews will be held in Room 632 on the sixth floor of the N.Y. Trade Show Building, 7th Avenue and W. 35th Street during Automation Week. Telephone LOngacre 5-7800. Extension 632

OR

If more convenient send your resume to

Mr. Wayne L. Besselman
Coordinator of Technical Employment

LEEDS & NORTHRUP CO.

4901 STENTON AVENUE
PHILADELPHIA 44, PA.

News Bits

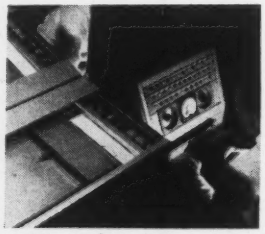
ACOUSTICA ASSOCIATES, INC., Glenwood Landing, N. Y., has delivered to the Atomic Energy Commission an ultrasonic cleaning and degreasing system "considered to be the largest and most powerful . . . in the world." System will be powered by high-frequency generators totaling 20 kilowatts.

FEDERAL TELEPHONE AND RADIO CO., Clifton, N. J., has acquired certain assets of Electronic Specialty Co., Los Angeles, Calif., and has started production at Clifton of large screen precision oscilloscopes and associated equipment.

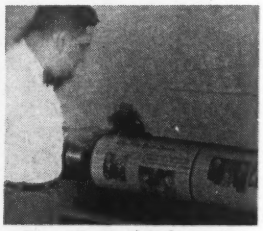
GULTON INDUSTRIES, INC., Metuchen, N. J., under terms of an agreement with Societe d'Applications Supersoniques, Paris, will manufacture and market in this country the Multiwhistle RD Air-Jet Ultrasonic Generator said to be capable of dispersing fog.

J. B. REA CO., Santa Monica, Calif., manufacturer of READIX computers, is using its product to predict the future of the company. The "brain" is actually forecasting its own future.

WESTINGHOUSE ELECTRIC CORP., Pittsburgh, Pa., has developed AUTOMEX an electronic brain that profits by its own mistakes.



Westinghouse's Automex



Times Facsimile's facsimile

TIMES FACSIMILE CORP., N. Y., recently transmitted an edition of the New York Times Newspaper to San Francisco at the rate of two minutes per page.

NEW YORK UNIVERSITY has been established by the Department of Defense as a national center for monitoring research and development on electronic test equipment.

GENERAL ELECTRIC has developed an inexpensive ultrasonic rotor inspection simulator for the training of ultrasonic inspectors of large turbine and generator rotor forgings.

LOGISTICS RESEARCH INC., Redondo Beach, Calif., has placed with Hughes Aircraft the largest single order for germanium diodes—one million for use in circuits of their ALWAC computers and other data-processing equipment.

ISOTOPE PRODUCTS, Buffalo, N. Y. has ordered a 15,600-curie cobalt source to be used in an Irradiation Pilot Plant, which is to be built as one stage of a new radiation service for industry.

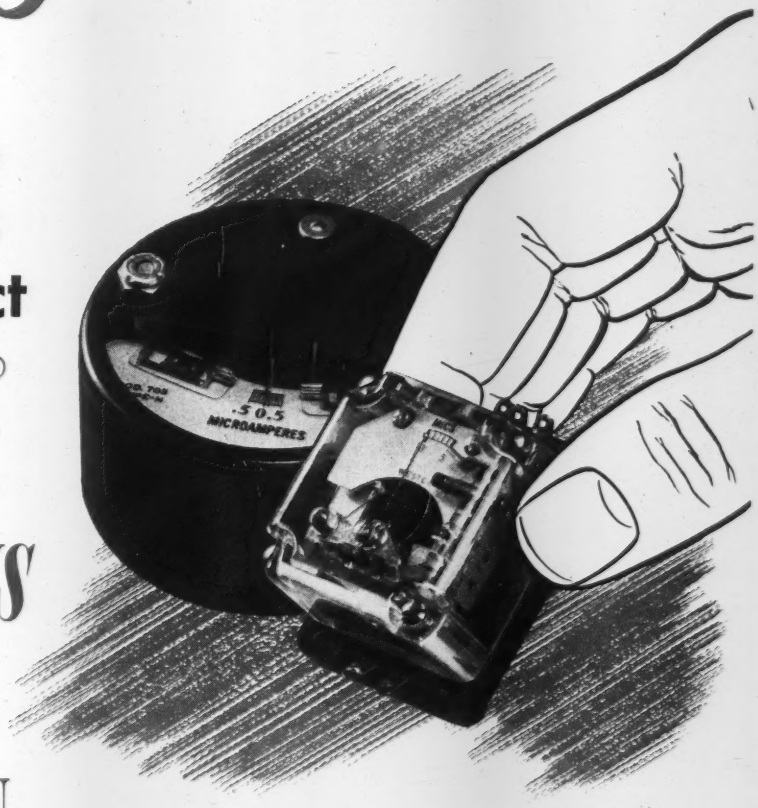
Forget the Amplifier

If your design utilizes an amplifier to boost a minute signal for relay operation – or, if you have 'shelved' some new product idea because the cost, space requirement and other drawbacks of amplifiers made the design impractical – *Sensitrol relays are for you.* For these tiny, ultra-sensitive relays, which operate direct on input signals as slight as *1 millivolt* or *½ microampere*, and handle substantial wattage at *110 volts*, entirely replace amplifiers, vacuum tubes and auxiliary power supplies. They are available with single or double contacts, fixed or adjustable, manual or solenoid reset. For engineering assistance in adapting Sensitrol relays to present products, or new problems you have in mind, call your nearest Weston representative, or write for the Sensitrol bulletin B-25-B . . . *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.*

Boost feeble input signals with compact

Sensitrol®

ultra-sensitive *relays*



WESTON *Instruments*

A DAYSTROM UNIT

build reliability into your product with OHMITE® COMPONENTS

close-control RHEOSTATS

All-ceramic and metal, close-control rheostats for unsurpassed dependability and smoothness of operation. Ten stock sizes, 25 to 1,000 watts.

wire-wound RESISTORS

A wide range of dependable, fixed, adjustable, tapped, and noninductive power wire-wound resistors. Also a wide range of precision resistors.

general-purpose RELAYS

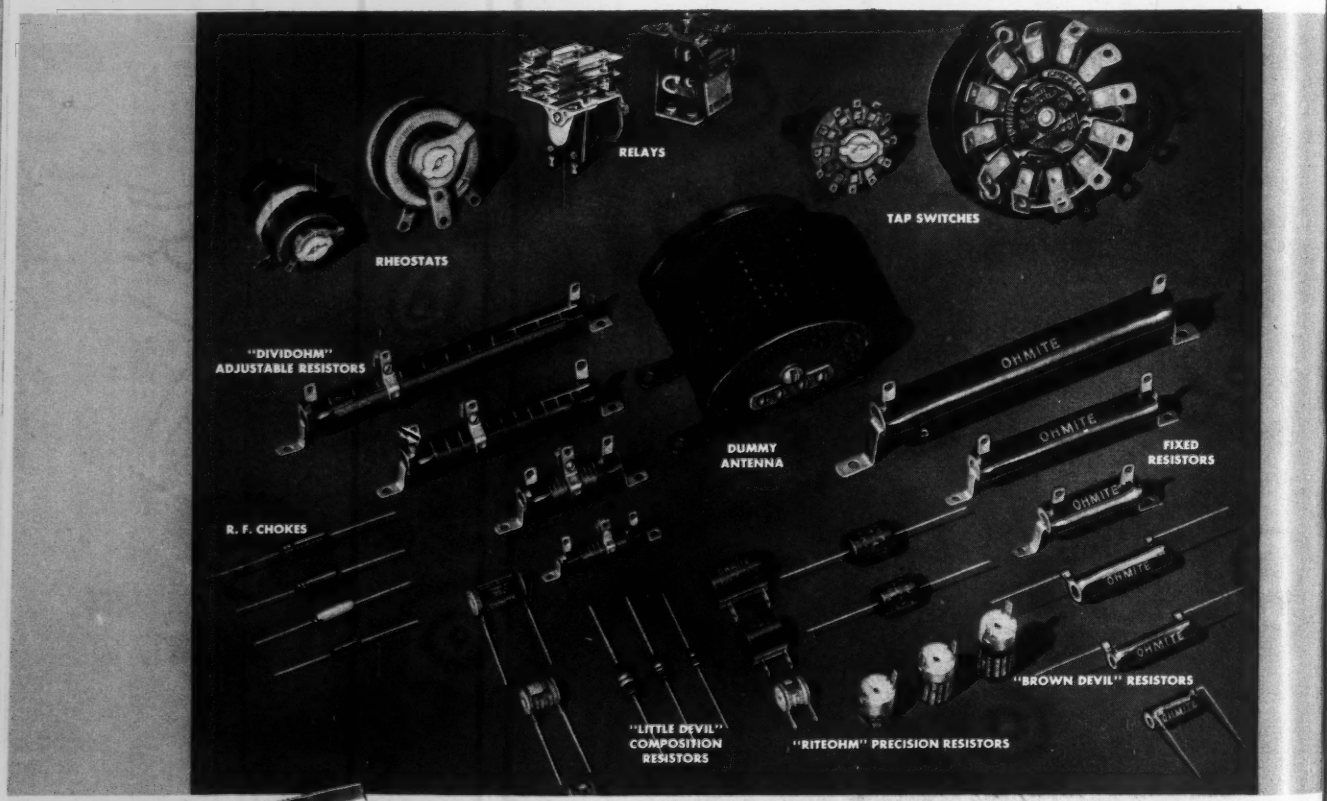
65 Types in four stock models. Good delivery on made-to-order relays. Contact current ratings up to 25 amps, AC or DC. Wide variety of contact arrangements. Hermetically sealed or dust-protective enclosures available.

high-current TAP SWITCHES

Five compact models, up to 100 amperes, AC, up to 12 taps. All-ceramic and metal construction. Silver-to-silver contacts, with self-cleaning rotor contact.

radio-frequency CHOKES

Single layer R.F. plate chokes and power line chokes on steatite or plastic cores. Protected by a special moisture-resistant coating.



WRITE on Company Letterhead for Catalog and Engineering Manual.

Be Right with OHMITE®

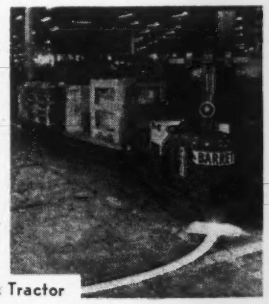
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES • TANTALUM CAPACITORS

OHMITE MANUFACTURING COMPANY • 3615 Howard Street, Skokie, Illinois

For more information circle **27** on inquiry card.

DEPARTMENT OF THE INTERIOR, Geological Survey has received their first engineering model of SURWAC (Surface Water Automatic Computer). It is undergoing tests to process river gage-height charts automatically.

SURWAC Computer



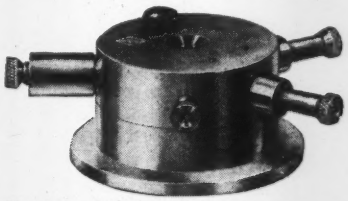
Optical-type Automatic Tractor

BARRET-CRAVENS CO., NORTHBROOK, ILL., announce development of an industrial tractor which requires no operator. The electronic optical type tractor needs only a painted white line as a guide.

AIR RESEARCH AND DEVELOPMENT COMMAND announces awarding contracts to modify small cargo freighter ships to be used as instrumentation stations to receive performance data from missiles soaring over the 3,000 miles of Atlantic between St. Lucia and Ascension Islands.

ASSOCATION OF AMERICAN RAILROADS, Signal Section Annual Meeting, featured an electronically controlled system that enables freight cars to steer themselves through railroad yards.

FOR MEASURING RADIOACTIVE EMISSION



8.3 x 6.5 x 3.5 cm. Weight 0.17 kg.

LINDEMANN-RYERSON ELECTROMETER

Was first used for photo-electric measurements. Is now used in conjunction with ionization chambers for the determination of radioactive emission. Compact, sturdy, high sensitivity, stable zero and requires no leveling. Capacitance is about 3 cm. Includes improvements developed by the Ryerson Laboratory.

OTHER CAMBRIDGE INSTRUMENTS

GAMMA-RAY POCKET DOSIMETER

is a personnel monitoring instrument to measure cumulative exposure to gamma or x-rays over a given period. Contains an ionization chamber; a quartz fibre electrometer and viewing system.

"CHANG AND ENG" FAST NEUTRON DETECTOR

follows closely original design of U. S. Atomic Energy Commission. Consists of twin ionization chambers, Lindemann Electrometer, reading microscope and dry cells. Self-contained.

PRECISION IONIZATION METER (Failla Design)

A complete instrument for null methods of radioactivity measurement where background radiation effects must be eliminated.

Send for complete information

CAMBRIDGE INSTRUMENT CO., INC.

3526 Grand Central Terminal, New York 17, N. Y.

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle **28** on inquiry card.

PANEL SPACE LIMITED? SPECIFY

DIALCO® 2-Terminal Sub-Miniature Pilot Lights

COMPACT
RUGGED
OMNIDIRECTIONAL PLASTIC DOMES
COMPLETELY INSULATED

Also available with "Taper-Tab" quick-connect terminals

BACK of panel insertion

or FRONT of panel insertion

△ Dimming and ◁ Non-dimming types

Also

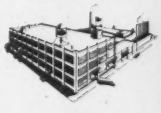
1-Terminal Pilot Lights

for use on grounded circuits. Available with *binding screw* or *soldering* terminal.

DIALCO's expanded line of sub-miniature lights conform to all applicable Mil Specs. Use T-1¾ midget incandescent lamps—1.3 to 28 V. Spring mounted *Lens-with-Message* is readily positioned *after* installation... Mount from *back* of panel in 15/32" clearance hole; or from *front* of panel in 17/32" hole... 7 lens colors... Shown approx. actual size (top to bottom): No. 134-3830-375-6... No. 101-3830-951... No. 101-5030-951... No. 109-3830-111... No. 111-3830-111... No. 107-1930-951.

Complete details in Brochures L-156 A and L-157.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE



Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

42 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600

DIALIGHT CORP., 42 Stewart Ave., Brooklyn 37, N. Y.

☐ Send brochures on Sub-miniatures ☐ Selection Brochure ☐ Pilot Light Catalogues

Name ..... Position .....

Company .....

Address .....

For more information circle **29** on inquiry card.

Education News

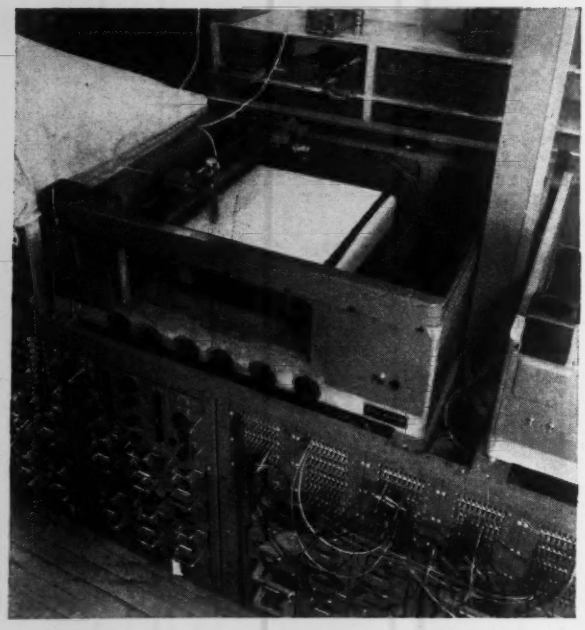
FULTON SYLPHON DIV., Robertshaw-Fulton Controls Co., Knoxville, Tenn., has offered three 4-year scholarships valued at $2200 each to qualified Knox County students who wish to study mechanical or electrical engineering at the University of Tennessee.

NEWARK COLLEGE OF ENGINEERING, Newark, N. J., has instituted a program of education and employment to promising college graduates. The assistant instructor's teaching schedule is designed not to exceed 15 hrs., to provide him time to complete graduate studies within three years.

NATIONAL HOME STUDY COUNCIL has warned that many of the home study courses are being offered by sub-standard organizations. A list of acceptable HS Schools is available at the public library or from NHSC, 510 Evans Bldg., Wash. 5, D. C.

U. S. DEPT. OF HEALTH, EDUCATION, and WELFARE announces availability of graduate training awards for engineers and allied professional personnel in public health specialties.

NATIONAL BUREAU OF STANDARDS announces plans to broaden summer employment opportunities, at a government research laboratory, for physical science and engineering majors and also selected high school students who display unusual talent.



MIT Function Generator
plots curves on a special Bristol strip chart

The strip chart above was designed and printed by Bristol especially for the MIT function generator.

It's one of hundreds of special strip and circular charts Bristol turns out each year to instrument builder specifications.

Why Bristol? Several reasons: We've been printing precision instrument charts for over 65 years, for one thing. We're familiar with instrumentation problems, for another. And, already one of the largest chart printers in the country, we've recently expanded our production facilities and engineering service.

What does this mean to you? It means that at Bristol you can get circular charts up to 12 inches in diameter—strip charts up to 29⅝ inches across. You can get charts for all kinds of special instruments—research, industrial, test, analytical, scientific, laboratory and pilot plant instruments and computors, to name a few. You can get charts printed on wax-coated, heat-sensitive, chemically-coated, electrically-sensitive or other special papers.

What's more, it will pay you to call on Bristol's chart service when your recorder is in the design stage. Put our long experience in designing both instruments and charts to work for you. Write the Bristol Company, 154 Bristol Road, Waterbury 20, Conn.

FREE BULLETIN Y1904 tells how Bristol Charts are made. Write for your copy.

6.17

BRISTOL *Points the Way in Human-Engineered Instrumentation*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

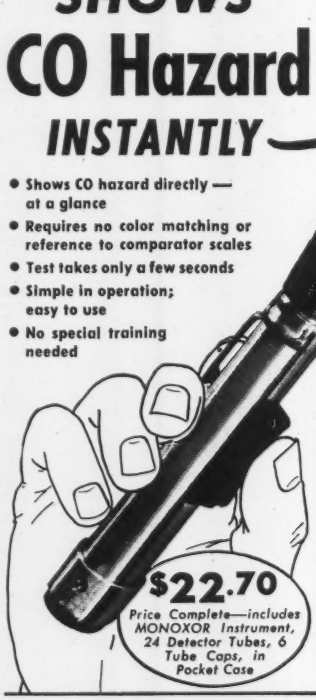
For more information circle **30** on inquiry card.

SHOWS CO Hazard INSTANTLY

- Shows CO hazard directly — at a glance
- Requires no color matching or reference to comparator scales
- Test takes only a few seconds
- Simple in operation; easy to use
- No special training needed

MONOXOR CARBON MONOXIDE DETECTOR

REPLACEABLE DETECTOR TUBE CONTAINS YELLOW CHEMICAL WHICH TURNS BROWN WHEN AIR "SNIFFED" THROUGH DETECTOR TUBE BY PENCIL-SIZE ASPIRATOR CONTAINS CARBON MONOXIDE



The MONOXOR detects presence of CO, even in concentrations as low as 100 parts CO per million parts of air. Particularly useful for a spot-check of carbon monoxide contamination in garages, vehicular tunnels, mines, industrial plants and wherever gas appliances are operated.

$22.70
Price Complete—includes MONOXOR Instrument, 24 Detector Tubes, 6 Tube Caps, in Pocket Case

For Complete Particulars . . . Clip this ad and mail to us with your name and address, or write for Leaflet 859.

BACHARACH INDUSTRIAL INSTRUMENT CO.
7301 PENN AVENUE • PITTSBURGH 8, PA.
Telephone: MOntrose 1-0702

M-9r

For more information circle **31** on inquiry card.

New Underwood Servotyper records data automatically

Underwood proudly presents the new Servotyper for automatic recording of digitized and alphabetic data, plus all the advantages of the well-known rugged durability of the Underwood Electric Typewriter.

The Underwood Servotyper is a slave electric typewriter. The keys are operated by solenoids which are triggered by electrical signals, at speeds up to 11 characters per second. A great variety of standard devices—quantizers, digital converters, diode matrices, transducers with digital outputs, etc., can be used for translating data into electric signals. These signals are simply and directly used as inputs for automatic operation of the Underwood Servotyper.

The Underwood Servotyper can be applied to many data logging and telemetering problems—test and research results, process variables, maintenance data, meteorological data, etc.—anywhere information is secured by electrical instruments. For complete specifications and wiring diagram of the Underwood Servotyper, call your Underwood Office (the number is in the Yellow Pages of your phone book), or write Underwood Corporation, One Park Avenue, New York 16, New York.

Features of the new Underwood Servotyper

- Solenoid operation of all keys, space bar, shift key, back space, carriage return, tabulation and red ribbon.
- Solenoid operated by 100-volt direct current at 100-milliamperes d.c. with nominal resistance of 1,000 ohms. Also available with 24-and 48-volt d.c. Solenoids.
- Speed of operation to 11 characters per second.
- Self governing feedback provides true Servo operation; supplies proper pulse to govern associated equipment, so that it operates at maximum typing speed.
- Prices from $730.00

UNDERWOOD UNDERWOOD **CORPORATION**

ONE PARK AVENUE, NEW YORK 16, N. Y.

For more information circle **32** on inquiry card.

TWO *pressure switches for the price of* ONE

At two predetermined set points in the same pressure system, Model 424 actuates two independent electrical circuits. One may be AC and the other DC if necessary.

MELETRON

MODEL 424

Typical applications are: in instrument air control as high-low warning, or as a lubrication system warning and safety shut down. If oil pressure drops below normal, a warning circuit is actuated and if pressure drops below the safe point, the machine is shut down.

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

To get complete operating data and specifications ask for bulletins 424 and 425.

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **33** on inquiry card.

Stock Report

The following prices and price ranges are supplied by Bache & Co., 36 Wall Street, New York 5, New York.

New York Stock Exchange:

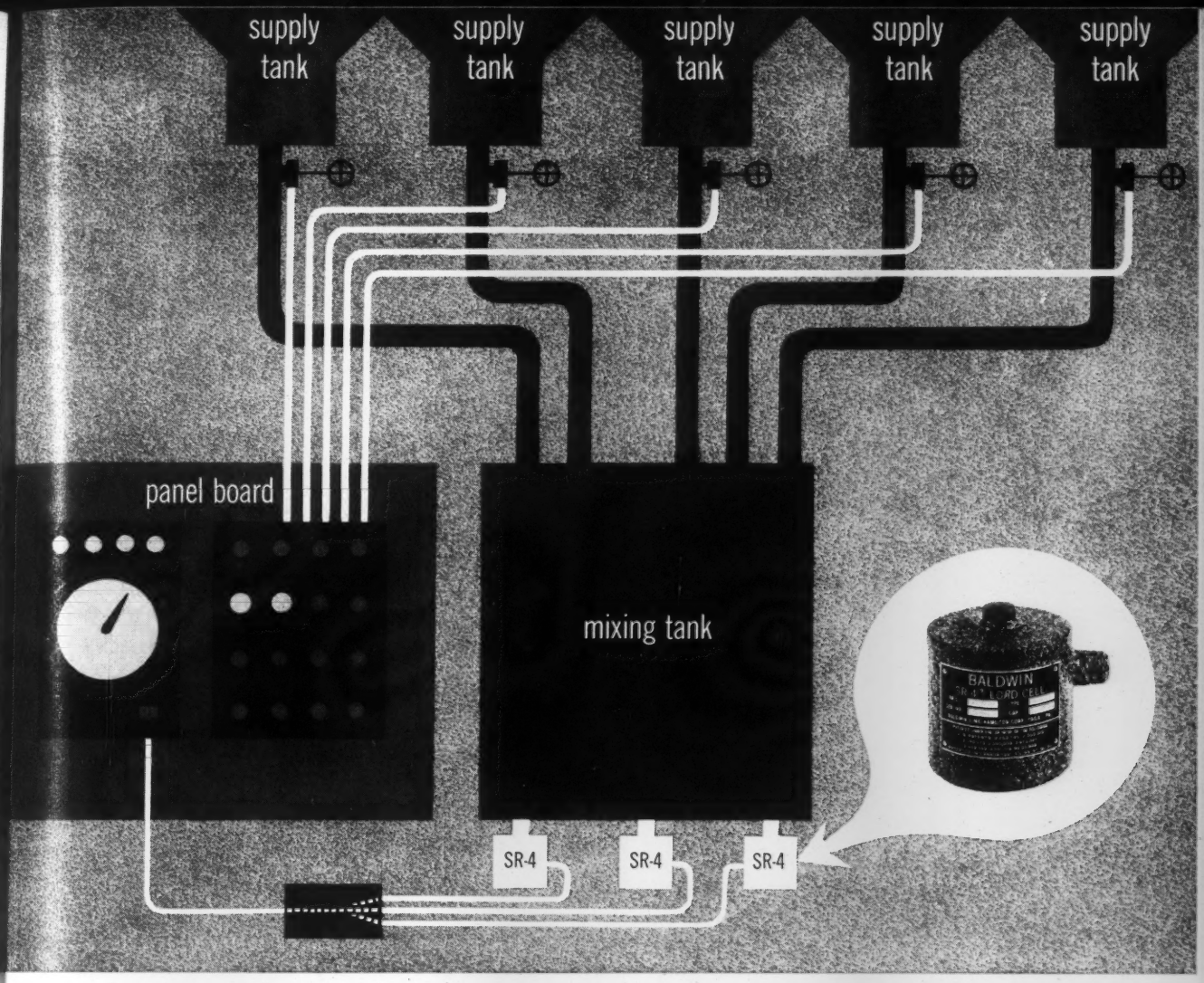
Security	Price Range for 1956 Thru Sept. 28 High	Low	As of Sept. 28
ACF Industries	67 7/8	55 3/4	56 5/8
Aerequip Corp.	15 3/8	11 7/8	14 5/8
Allis Chalmers	37 1/4	31 3/8	32 1/8
American Chain & Cable	54 3/4	38 1/2	53 1/8
American Machine & Foundry	33 3/4	24 1/8	32
American Machine & Metals	43 3/4	35 1/8	39 - 39 5/8 (1)
American Optical	40 3/4	34 1/2	34 7/8
American Tel. & Tel.	187 1/8	169	169 1/8
Argus Camera	27 1/2	20 1/2	21 3/4
Beckman Instruments	38 1/2	25 1/8	33
Bell & Howell	45 1/2	29 1/4	40 1/2
Bendix Aviation	63	48 1/2	56 3/8
Boeing Airplane	59 1/8	45 3/8	51 7/8
Bullard	38 3/8	29 5/8	30 1/2
Bulova Watch	23	20 1/4	20 5/8
Burroughs	46 7/8	28 1/2	40 5/8
Carborundum	45 1/8	31 1/2	40 3/4
Cincinnati Milling Machine	55 1/4	37 1/4	45
Clevite	24 1/4	18	18 7/8
Columbia Broadcasting 'A'	32 7/8	22 5/8	28 5/8
Consolidated Electronics	36 1/2	26 3/4	27
Cornell Dubilier	40 1/8	25 1/8	25 1/4
Corning Glass	87 1/2	64	68
Curtiss-Wright	41	26 3/4	38
Cutler Hammer	61 1/4	54 3/4	55 1/8
Daystrom	27 1/8	22	25 1/4
Dobeckmun	39 1/4	28 3/4	30
Douglas Aircraft	95 5/8	72 1/2	85 3/4
Eastman Kodak	100 3/4	75 3/4	87 1/4
Eaton Manufacturing	65 3/8	51 1/2	61 3/4
Electric Auto Lite	41 3/8	33 1/8	35 1/2
Elgin Watch	17 3/8	14	14 5/8
Food Machinery & Chemical	77	51	62 1/8
Gamewell	32 3/3	25 5/8	29 1/4
Garrett	53 1/2	38	50 1/4
General Dynamics	79 1/4	56 5/8	71 1/4
General Electric	65 1/2	52 3/4	56
General Instrument	10 1/8	7	7
General Mills	71 3/4	61	68 1/8
General Precision Equipment	53 1/2	37 3/8	37 1/2
General Railway Signal	90 3/4	61 1/2	86 1/2
General Telephone	46	36	40 3/4
General Time	33 1/8	29 1/2	31 1/8
General Tire	66 3/4	50	50 1/4
Goodyear	81 1/2	60	72
Hamilton Watch	27	19	25 1/4
Hoffman Electronics	25 3/8	20 1/2	22 7/8
International Business Mach.	523	400	453
International Tel. & Tel.	37 3/8	29 1/4	31 3/8
Lockheed Aircraft	53 3/3	43 1/4	48 7/8
Magnavox	41	33 1/4	33 1/4
Minneapolis Honeywell	90 1/2	58	75 1/2
Minnesota Mining & Manufacturing	75 1/2	61 1/8	63 1/4
Motorola	51 3/4	40 1/8	45 3/8
National Acme	82	62	71 1/2-73 (1)
National Cash Register	59	34 4/8	47 3/8
North American Aviation	49 7/8	40 3/8	41 1/2
Northrop	29 1/8	21 1/4	23
Otis Elevator	50 3/4	33 1/4	44 1/2
Philco	36 1/2	19 3/4	20
Radio Corp. of America	50 3/8	37 3/4	38
Raytheon	19 1/2	13	16 1/4
Rheem Manufacturing	37 1/8	19 7/8	22 7/8
Robertshaw Fulton	28 3/3	21 1/2	23
Sangamo Electric	37 1/2	29 1/2	32 7/8
Sperry Rand	29 1/8	23 5/8	24 1/4
Square D	82	51 1/2	68 5/8
Standard Coil	12 3/4	8 1/2	9 1/8
L. S. Starrett	58 1/2	43 3/4	51
Stewart-Warner	39 1/2	31	31 1/8
Sylvania Electric	55 7/3	42	47 1/2
TelAutograph	15 1/4	11	11 3/4
Texas Instruments	17	11 5/8	14 3/4
Thompson Products	72 1/2	48 3/8	66 1/4
Tung-Sol Electric	36 3/8	27 1/4	27 5/8
Underwood Corp.	44	25 1/2	26 1/8
Union Carbide & Carbon	133 3/8	103 1/4	112 1/4
Western Union	22 1/2	18 5/8	19
Westinghouse Air Brake	36 3/8	29	30 1/8
Westinghouse Electric	65 7/8	51 1/2	53 1/4
Worthington Corp.	59 1/2	41 1/8	51 3/4

(1) Bid - Asked price; no sale.

American Stock Exchange:

	Price Range for 1956 Thru Sept. 28 High	Low	As of Sept. 28 Last
Air Associates	13 1/2	9	9 7/8
Aro Equipment	24	18 3/4	19 3/4
American Meter	41	33	34
Belock Instrument	19 3/8	13 1/2	19
Bendix Watch	10 5/8	8 1/8	8 1/2 - 8 1/2(1)
Breeze Corp.	9 1/8	6	6 1/8
Clark Controller	37	16 1/4	29 1/8
Clarostat Mfg.	5	3 5/8	3 5/8
Clary Corp.	6 7/8	5 1/8	5 1/8
Consolidated Electrodynamics	32 1/2	21	28 7/8
Du Mont Labs.	10	5 5/8	6
Dynamics Corp. of America	8 3/8	6 1/8	6 1/8
Electronics Corp. of America	24 1/4	11 1/2	12 5/8
El-Tronics	9 7/8	3 1/2	4 1/8
Fairchild Camera & Inst.	25 7/8	19 1/2	20
Globe-Union	22	17	17 3/8
Hazeltine Corp.	48	37 5/8	37 3/4
International Resistance	8 1/4	5 1/4	5 1/4
Lear Inc.	10 1/2	7 3/8	8
National Resistance Corp.	29 3/4	17 7/8	18 1/4
Neptune Meter	36	28 3/8	31
New Haven Clock	2 1/2	1 1/2	1 1/2
Norden-Ketay	14 7/8	7 7/8	8 1/8
Nuclear Corp. of America	2 1/2	1 5/8	1 3/4
Pneumatic Scale	28 1/4	24	25 1/2 - 26 (1)
Reliance Electric	58 1/2	38 7/8	52 1/2 - 54 1/2(1)
Servo Corp. of America	7 3/4	5 1/3	6 1/4
Servomechanisms	11 3/8	8 1/4	11 3/3
United Shoe Machinery	61 5/8	42	43
Wallace & Tiernan	25 1/2	19 1/2	22 1/2
Waltham Watch	3	1 1/4	1 5/8

(1) Bid - Asked price - no sale.



Baldwin electronic SR-4® system controls chemical process to ±¼% accuracy

Closed loop control of this chemical plant's mixing process is provided by an integrated Baldwin SR-4 system with a maximum degree of accuracy and repeatability.

To add the correct amount of each ingredient, the Baldwin indicator controller automatically opens and closes supply tank valves. The controller receives its signals from three Baldwin SR-4 transducers which weigh each ingredient as it is added to the batch. Load cells install conveniently just below the mixing tank. Baldwin load cells are instantaneously responsive, have no moving parts, require no maintenance. The mixer is timer actuated. Lights on the panel board show cycle stage at all times.

You can have a Baldwin SR-4 electronic control system, specifically designed for your requirements, for any application involving weight, pressure, tension, torque or thrust. We engineer the entire system and calibrate it as a unit, to guarantee you maximum accuracy. For your copy of our general bulletin 4300, write Dept. 3253, Electronics & Instrumentation Division, BLH Corporation, Waltham, Massachusetts.

SEE OUR EXHIBIT AT THE AUTOMATION SHOW

BALDWIN BLH LIMA-HAMILTON

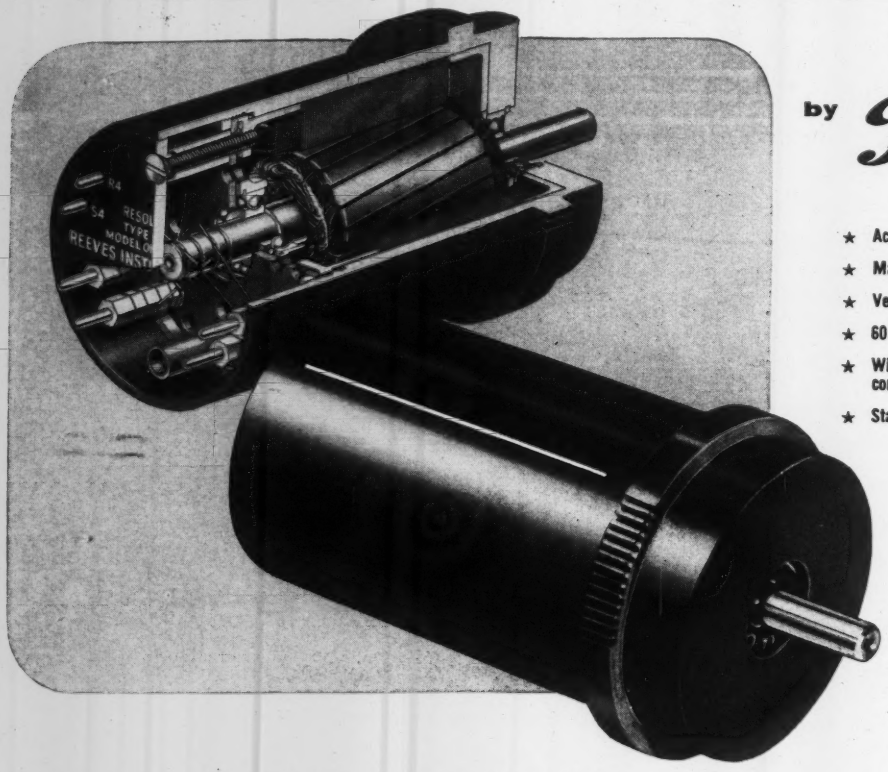
ELECTRONICS & INSTRUMENTATION DIVISION

BALDWIN-LIMA-HAMILTON

DIVISIONS: Austin-Western • Eddystone • Hamilton • Lima • Electronics & Instrumentation • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works

For more information circle **34** on inquiry card.

PRECISION RESOLVERS



by Reeves INSTRUMENT CORPORATION

- ★ Accuracy better than 0.05%.
- ★ Maximum interaxis error as low as 1'.
- ★ Very low distortion.
- ★ 60 or 400 cps. or wide band.
- ★ With or without booster amplifier compensation.
- ★ Standard military frame sizes.

See our exhibit
BOOTH 333
3rd International
AUTOMATION
Exposition
New York,
Nov. 26-30

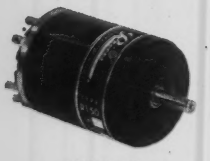
the HIGHEST PRECISION resolvers available

Reeves' many years of experience as a pioneer in the field has made it possible to manufacture these compact precision resolvers in quantity production to a functional accuracy of 0.05% without culling—or to an accuracy of 0.03% on special order. Harmonic distortion and null voltages are held below one-tenth of one per cent.

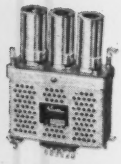
Reeves resolvers are primarily designed for 60 and 400 cps. operation, with or without booster amplifier compensation. Special units are available for use at over 100 kc bandwidth. The Reeves R600 series is the standard of comparison among precision resolvers. Miniature resolvers of highest precision are also available.

Write for the Reeves Resolver Handbook.

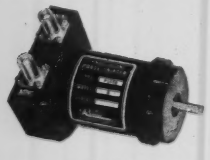
REEVES PRECISION RESOLVERS AND RELATED COMPONENTS



MINIATURE PRECISION RESOLVERS



BOOSTER AMPLIFIERS



PHASE SHIFTERS

CONTINUOUS RESOLVER CHECKER

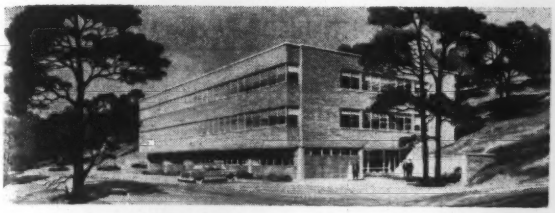
Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

A Subsidiary of Dynamics Corporation of America

225 East 91st Street, New York 28, New York

For more information circle 35 on inquiry card.



New Plants and Mergers

GENERAL PRECISION LAB. INC. has started construction of a new engineering building for military electronics.

INTERNATIONAL BUSINESS MACHINES CORP. announces a new research center will be built in Yorktown, N. Y., to accommodate a staff numbering 1,600. IBM has also given autonomous status to its Time Equipment Div.

MANNING, MAXWELL & MOORE, Aircraft Products Div., announces a license agreement with Lee Co., to mfg. and distribute a new differential pressure transducer developed at Lee's research facilities.

ROBERTSHAW-FULTON CONTROLS CO. announces an extensive field service organization for reconditioning control devices.

BURROUGHS CORP. has started construction of a new building to double mfg. capacity.

BAIRD ASSOCS.-ATOMIC INSTRUMENT CO. has placed $750,000 of 10-year 5½% subordinated debentures for acquisition of facilities.

COMPUTER-MEASUREMENTS CORP., North Hollywood, Calif., is merging with Hancock Mfg. Co., Jackson, Mich., to expand mfg. and sales facilities.

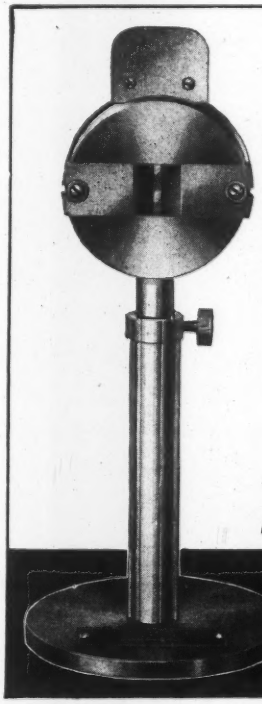
HATHAWAY INSTRUMENT DIV., Hamilton Watch Co., is building a new research and development plant in Denver.

CONSOLIDATED ELECTRODYNAMICS CORP., Rochester Div., has signed a reciprocal licensing agreement with W. C. Heraeus GmbH, Hanau, West Germany, for marketing high-vacuum equipment.

APPLIED RESEARCH LABS. is increasing its plant facilities in Europe to meet expanding demand for basic metals.

GENERAL CONTROLS CO. announces new and larger facilities in the St. Louis and Seattle districts.

STACKPOLE CARBON CO., St. Marys, Pa., completed its fiftieth year in business on August 8, 1956.



EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

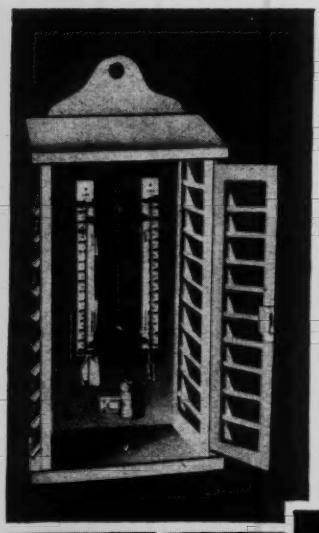
*Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.

BULLETIN No. 3 ON REQUEST—Address: 2 Sheffield Ave., Newport, R. I.

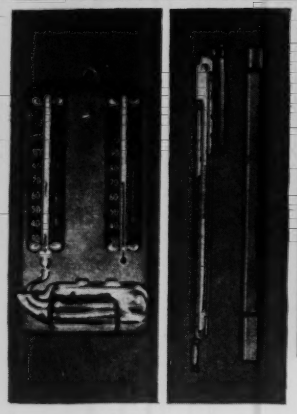
THE EPPLEY LABORATORY, INC.

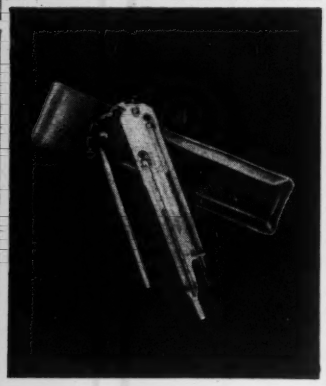
SCIENTIFIC INSTRUMENTS

NEWPORT, RHODE ISLAND, U. S. A.



You get dependability PLUS with Moeller psychrometers





because designing and manufacturing temperature measuring instruments and psychrometers has been our business since 1867.

Nothing's as changeable as the weather and the atmosphere unless it's the reading indicated on Moeller Psychrometers. For almost 90 years—whether indoors or out—Moeller Psychrometers have proven accurate, regardless of climatic conditions.

Send for descriptive literature, today!

MOELLER INSTRUMENT COMPANY
132nd ST. and 89th AVE
RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

Gentlemen: Without obligation, please send me Catalog No. 150 on Moeller Psychrometers.

NAME .....

FIRM .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

For more information circle **37** on inquiry card.

PLANTS —CONTINUED

MINNEAPOLIS-HONEYWELL purchased this three-story plant in Brighton to house the Transistor Div.

THE HALOID CO., Rochester, N. Y., and Bell & Howell Co., Chicago, announce signing a long-term patent license agreement providing technical cooperation for new product research in xerographic picture formation.

MAGNECORD, INC., Chicago, announces a new division, MagneMatic, to specialize in magnetic tape recording equipment for industrial applications.

ELECTRO-MEASUREMENTS, INC., announces their move into a modern 26,000 sq ft, tilt-slab building.

STROMBERG-CARLSON announces purchase of a modern 800,000 sq ft factory in Rochester, N. Y.

AMERICAN MACHINE & FOUNDRY CO. announces a $4 million research and development center will be built in Stamford.

FREE

INFORMATIVE BULLETIN

How to set new highs in precision measurement of low temperatures

This special low-temperature Alnor Pyrometer is invaluable for balancing hot water heating systems, checking floor, wall or ceiling temperatures in panel heating systems, measuring temperature of refrigerated coils, insulation and all other low temperatures. Sturdy and completely portable, the Type 2300 can be taken anywhere—and give precise, direct readings in from 3 to 5 seconds.

Tear out this ad and attach it to your letterhead. Mail to Illinois Testing Laboratories, Inc., Room 518, 420 North LaSalle Street, Chicago 10, Illinois.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **38** on inquiry card.

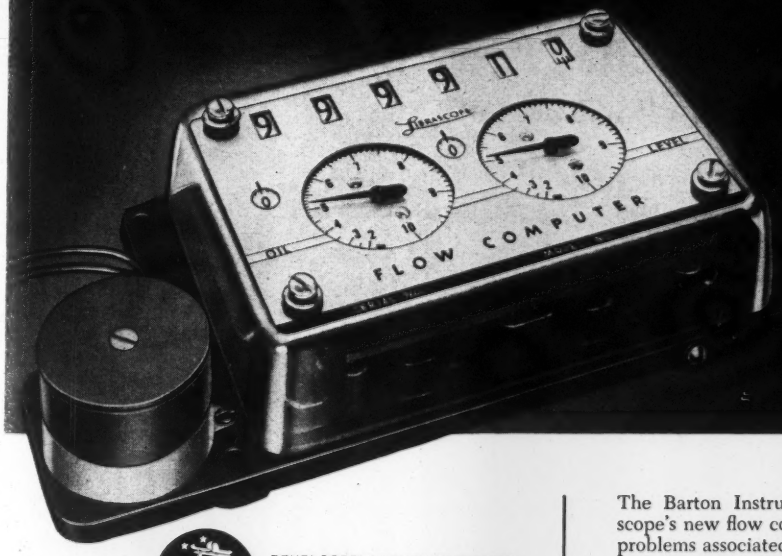
COMPLETELY

MECHANICAL–

FULLY RELIABLE

Barton Model 236 Flow Meter
Combines Barton Model 199 rupture-proof bellows unit with Librascope Flow Computer. No cams, intermittent devices with built-in switch for remote reading.

Librascope's pressure-compensated, totalizing flow computer



HIGH ACCURACY

MADE POSSIBLE

THROUGH

CONTINUOUS

INTEGRATION

DEVELOPED AND PRODUCED BY
LIBRASCOPE, INC.
GLENDALE 1, CALIFORNIA

A SUBSIDIARY OF GPE

The Barton Instrument Corporation now distributes Librascope's new flow computer, a unique design that solves many problems associated with flow computation. In addition to the high degree of *reliability* inherent in mechanical, non-electrical devices, and *accuracy* made possible by continuous integration of static and differential pressures—this unit provides considerable cost *savings* by eliminating the time consuming and often inaccurate function of hand integration. Revolutionary in design, the computer fits new or old meter cases, and existing air transmission systems. It may be ordered with electrical or hand-wound drives. Write Barton for further details.

Distributed throughout the Western Hemisphere by

Representatives in most principal cities.

BARTON
INSTRUMENT CORPORATION

Manufactured by—LIBRASCOPE, INCORPORATED • 808 WESTERN AVENUE • GLENDALE, CALIFORNIA
Sold by—BARTON INSTRUMENT CORPORATION • 580 MONTEREY PASS ROAD • MONTEREY PARK, CALIFORNIA

For more information circle **39** on inquiry card.

From MOOG . . . **a Dual Input Servo Valve for Flight Control**

Pilot boost servos for contr . surface positioning are commonplace. These servos are usually necessitated by high control surface aerodynamic loads which make direct control through the pilot's stick impracticable. Generally, they are mechanical-hydraulic in nature.

Today, as aircraft operational requirements increase, it is necessary to add artificial flight stability augmentation through these servos. Also, aircraft autopilots must work through this medium. These modes of operation generally require electro-hydraulic servos.

To coordinate these functions, the Moog Valve Company introduced, and is now in full production on, its Dual Input Servo Valve. These units permit direct mechanical-hydraulic flight control, combined mechanical-hydraulic and electro-hydraulic control, and electro-hydraulic control alone. Full mechanical override for safety is always possible and self-contained solenoid and lock-out arrangements permit full flight mode selection.

Employing an entirely new principle of summation, the Moog units accomplish the electro-mechanical mixing function without linkage in a single, integrally-designed package. By elimination of linkage inertia and backlash, the Moog Dual Input Valve greatly increases low amplitude resolution and frequency response. It simplifies the entire control system and is far more compact than other dual input mechanisms.

The Dual Input Servo Valve was developed by Moog's creative engineering staff. This team approach is available to industry to produce advanced electro-hydraulic servo components.

MOOG VALVE CO., INC., PRONER AIRPORT, EAST AURORA, N.Y.

MOOG

For more information circle **40** on inquiry card.

KYBERNETES CORP. announces appointment of *H. T. Sawyer* to vice president.

H. T. Sawyer
Kybernetes

W. C. Gray
Taylor

People IN THE NEWS

TAYLOR INSTRUMENT COS. announces six promotions in industrial sales. *Harry G. Olson* will be divisional sales manager to textile, refrigeration and metals industries. *Warren C. Gray* will be divisional sales manager to chemical and paper industries, *Donald Warner* will head the Greensboro branch, *Robert B. Reynolds* will be sales manager, Chicago Branch, John Humphrey will be manager, Philadelphia branch, and *Ernest A. Capelle* will be manager, Washington-Baltimore territory.

WESTINGHOUSE AIR BRAKE CO., Industrial Products Div., announces appointment of *E. L. Holbrook* as sales manager.

E. L. Holbrook
Westinghouse Air

H. Bandstra
Richardson

RICHARDSON SCALE CO. announces appointment of *Hart Bandstra* as advertising manager.

ELECTRODATA DIV., Burroughs Corp., announces appointment of *Yougene J. Lamar* as manager of product planning, and *Frank W. Ladwig* as manager of market development.

M. O. Jensen

MR. M. O. JENSEN, founder of Jensen Instrument Co. in 1923, member of Los Angeles Chamber of Commerce, National Association of Manufacturers, and North Shore AF & AM Lodge 937, Chicago, passed away on August 30, 1956, at the age of 64.

James F. Rinke

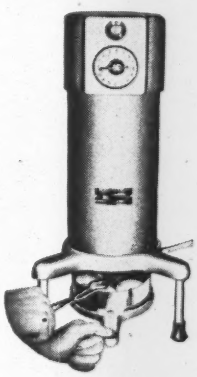
JAMES F. RINKE, director of engineering for Potter & Bromfield, Inc., died Sept. 23, 1956, at the age of 49. Mr. Rinke contributed to relay technology with many papers, including "Design Consideration in Selecting & Applying Relays."

Get accurate results FAST!

check moisture content with the

DIETERT-DETROIT MOISTURE TELLER

Determine the moisture content of any material quickly, easily and accurately with the modern, low priced Dietert-Detroit Moisture Teller. Direct testing method . . . no chemicals, calibrations or involved computations necessary. Ideal for research, analysis and control work.



See How Dietert-Detroit Moisture Tellers Speed up Testing Time!

Sample	Sample Size Grams	Temp. Degs. F.	Drying Time Min.
Sand	50	250	3
Paper	50	250	15
Salt	20	260	6
Soap	10	250	9
Color Pigment	10	212	12
Liquid Wax	5	250	15
Yeast	50	280	15
Licorice Extract	5	220	30
Pig Meal	25	250	25
Mash Pellets	25	255	25
Pulverized Oats	25	255	10
Glass Powder	10	250	20
Flour	25	250	12
Textile Fibers	20	300	15
Wood Pulp	25	250	7

New Catalog Ready Now!

Illustrates and describes complete line of Dietert-Detroit Moisture Testing Equipment, including Moisture Tellers, Speed Ovens, Speed Desiccators and accessory items. Moisture Teller No. 276 illustrated above.

HARRY W. DIETERT CO. CONTROL EQUIPMENT

9330 ROSELAWN DETROIT 4, MICH.

For more information circle **41** on inquiry card.

For Continuous Measurement And Remote Indication of Angular Position

*Patented

Use SCHAEVITZ *Rotary Variable* DIFFERENTIAL TRANSFORMERS*

The small, compact SCHAEVITZ RVDT produces a voltage whose magnitude varies linearly with change in the angular position of its shaft. It has complete electromagnetic shielding.

SCHAEVITZ RVDT'S are widely used in the continuous measurement and remote indication of angular position.

- primary excitation: up to 50 volts single phase ac in the medium audio frequency range of 400 cps to 20 kcps
- typical sensitivity: 9 millivolts/degree at 2000 cps with an input of 5 volts
- linearity: ± 1% over ± 40° and ± 3% over ± 60°
- input vs. output characteristic: symmetrical about the null point
- low operating torque: .014 in.-oz.
- low moment of inertia: 1.6 x 10^{-6} lb. in. sec.^{2}
- the shaft, which is mounted on ball bearings, may be continuously rotated

There is no rubbing or sliding friction of any kind in the SCHAEVITZ RVDT. Ask for further details.

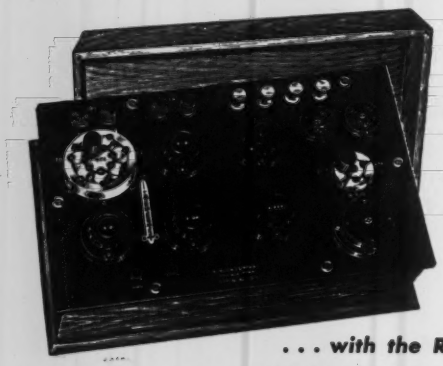
schaevitz engineering

P.O. BOX 505 • CAMDEN 1, NEW JERSEY
Merchantville 8-5353

For more information circle **42** on inquiry card.

Precise

TEMPERATURE MEASUREMENTS



. . . with the Rubicon
MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100

. . . with the Rubicon
PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer —permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

RUBICON COMPANY

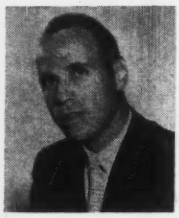
Electrical Instrument Makers

3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **43** on inquiry card.

PEOPLE —CONTINUED

PERKIN-ELMER CORP. announces appointments of *Joseph L. Borden* as head of the Infrared Instrument Development Section, *John H. Rhodes* as sales mgr. for laboratory analytical instruments, *Edward C. Berndt, Jr.*, sales mgr. for process control instruments, and *Vincent J. Coates*, mgr. for application engineering.



E. C. Berndt
Perkin-Elmer

R. H. Wheeler
B, S & B

BLACK, SIVALLS & BRYSON, INC., Controls Division, announces appointment of *Richard H. Wheeler* as manager of engineering.

ARNOUX CORP. announces appointment of *Walter Y. Fish* as chief engineer, and *Michael Dodak* as assistant director of marketing.

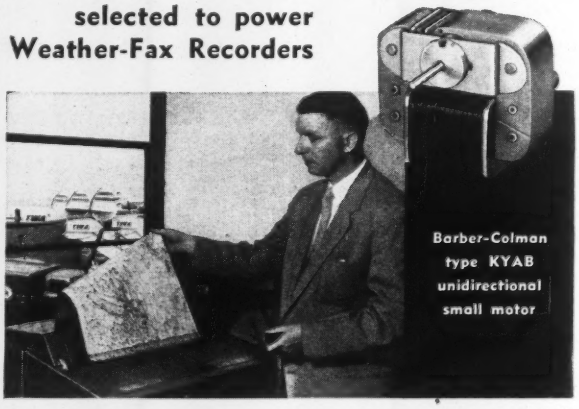
BROOKS ROTAMETER CO. announces appointment of *Henry F. Lorence* as advertising manager, and *Robert F. Gilman* as production engineer.

MANNING, MAXWELL & MOORE, INC., Industrial Controls Div., announces appointment of *Walter A. White* as sales engineer, Chicago district.

BARBER COLMAN

Small Motors

selected to power Weather-Fax Recorders



Twenty-four hours a day, over a 22,000 mile network, Weather-Fax facsimile recording machines automatically reproduce weather maps, charts, drawings, other data. To power the recording stylus mechanism, the maker chose the Barber-Colman type KYAB unidirectional motor. Write for Catalog F-4271-6 describing the wide selection of Barber-Colman motors available up to 1/20 hp. Unidirectional, synchronous, and reversible . . . with or without gearing . . . open or enclosed.

Barber-Colman Company

Dept. K, 1215 Rock Street, Rockford, Illinois

For more information circle **44** on inquiry card.

NEW DEPARTURE IS A HELPING HAND IN MINIATURIZATION

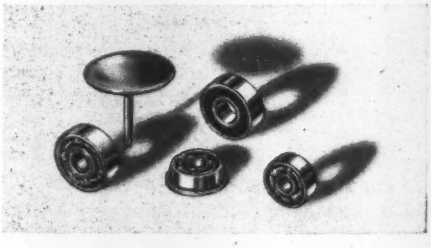
Volume is one of the big reasons why New Departure is the preferred source for miniature ball bearings.

And, of course, another big reason is ultra-precision! Despite their small size ($\frac{5}{32}$" to $\frac{1}{2}$" O.D.), New Departure miniature bearings are fully precision-ground, lapped, and honed to within tolerances of ABEC 5 or better.

Actually, precision starts with proper preparation of the stainless steel, where optimum metallurgical characteristics are assured by exacting heat treat equipment and processes. Finished bearings undergo rigorous testing and microscopic inspection on special equipment. Assembly and packaging take place in completely air-conditioned and pressurized areas to keep out contaminants.

However exacting your performance requirements, call on New Departure for miniature bearings unexcelled for precision, accuracy, and long life. New Departure, Division of General Motors, Bristol, Connecticut.

BALL BEARINGS MAKE GOOD PRODUCTS BETTER



SEE NEW DEPARTURE ON
"WIDE WIDE WORLD" SUNDAYS—NBC-TV

New Departure Division
General Motors Corporation
Bristol, Connecticut
Att. Dept. D

Gentlemen: Please send me free catalog on miniature bearings.

Name_____ Title_____

Company_____

Address_____

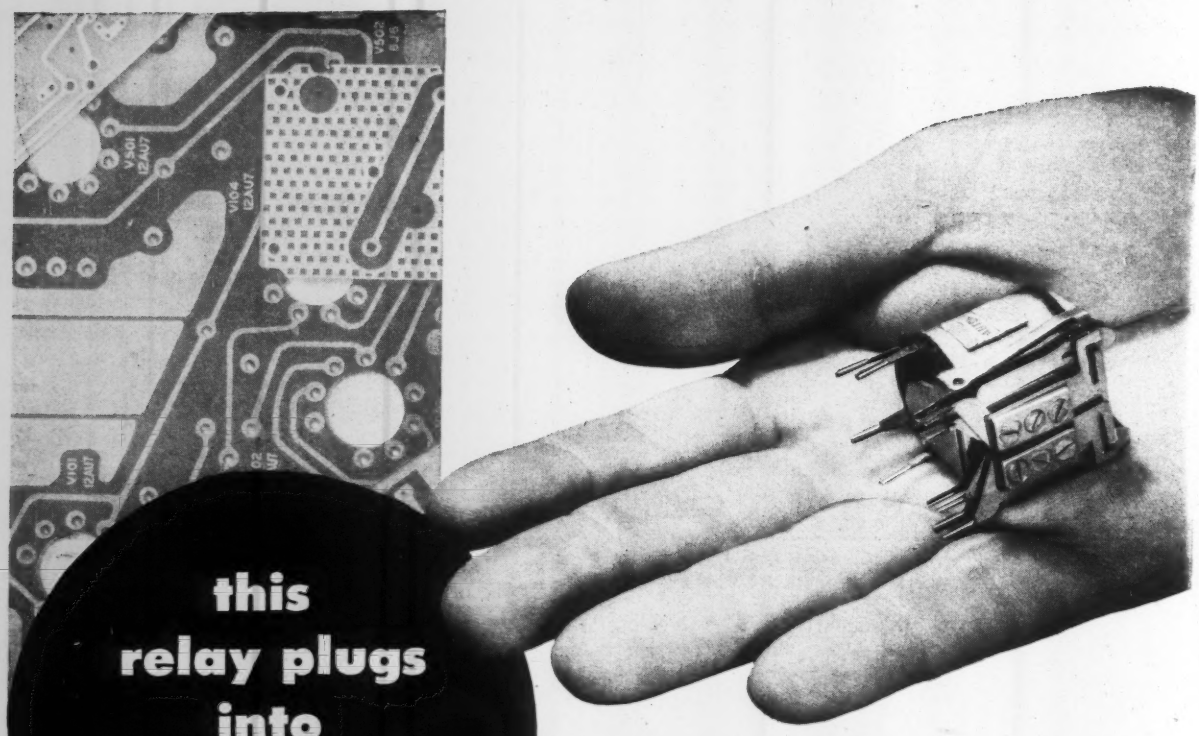
City_____ Zone____ State_____

NEW DEPARTURE
BALL BEARINGS

GM GENERAL MOTORS

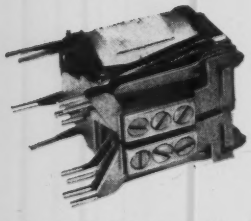
NOTHING ROLLS LIKE A BALL

For more information circle **45** on inquiry card.



this relay plugs into printed circuits

. . . and runs up to 120 million operations without attention.



HELPFUL INFORMATION FOR THE TECHNICALLY MINDED . . .

Dimensions: Length, 1¾"; height, 1⅝" to 1¾" (depending upon the number of contact springs); width, 1".

Operating Voltage: Up to 175 volts, dc, only.

Contact Spring Capacity: Maximum of 9 springs per pile-up.

Springs: Can be made of phosphor-bronze, "Bronco" metal, or other special purpose materials, as required.

A new stainless-steel armature bearing pin, a new sintered metal yoke, a new lubricating system for the armature—these features add up to 10 times the life of former relays. Automatic Electric Printed-Circuit Relays meet today's needs in automation, in computers, in any applications requiring utmost dependability.

Specially designed plug-in terminals are an integral part of the coil and of the contact springs. They make firm, tight, high conductivity connections with printed circuits—and may be permanently secured by using any recognized soldering technique.

Besides these features, you get efficient magnetic design, permanently welded contacts, "stay-put" contact springs and many other advantages found in all Automatic Electric relays. Save parts, assembly and wiring time by using printed circuits—and Automatic Electric Printed-Circuit Relays. For complete details, *write:* Automatic Electric Sales Corporation, 1033 West Van Buren Street (HAymarket 1-4300), Chicago 7, Illinois. *In Canada:* Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

AUTOMATIC ELECTRIC

Originators of the dial telephone · Pioneers in automatic control

GENERAL SYSTEM

For more information circle **46** on inquiry card.

SIGNIFICANCE

The purpose of our "Biographies of Significance" is to show the type of man who works with the instruments in our various fields of endeavor—the "user," and in so doing to show how he qualifies for this work, and what his major functions and problems are.

Joseph Conison, Instrument Supervisor for the Fluor Corporation, typifies the varied background and manifold interests of the instrument engineer in the processing industries. As his article "The Importance of Piping to Instrumentation" appears in this issue, we think it appropriate to recognize his important position within our field in the same issue, and to acknowledge his contributions to our field. Note particularly how he, like so many others you have met in this feature, worked hard and long to round out his background with proper and diverse education and experience that qualifies a man for "Instrument Engineering." Note also how he works at teaching others to become Instrument Engineers. On pages 2224-26 you will see the results of the Instrument Engineering work at Fluor.

JOSEPH CONISON

Joseph Conison, born in January, 1914, obtained his college education the hard—but effective—way, at the Evening Division of the University of Cincinnati, graduating in 1941 with a B. S. degree in Chemical Engineering. It took seven years to obtain this degree by attending classes four and sometimes five nights a week. (To this date, nobody else has ever completed a complete undergraduate program in seven years or less.) This schooling was concurrent with his employment during the day as a chemist at the Louis G. Robinson Laboratories.

Joe obtained varied experience in chemical and process engineering in the years between 1941 and 1947 as (1) Supervisor of Production and Development of the bituminous plastic dept., Randall Co., 1941-42, (2) Supervisor of the Chemical Engineering Dept., aluminum and magnesium foundries, Wright Aeronautical Corp., 1942-45, (3) Process Engineer on various methyl, ethyl, acetone and benzene units at Vulcan Copper & Supply Co., 1945-46, (4) Assistant to the Construction Superintendent of final phases of ethylalcohol plant erection and startup, including training of operators and shift supervision of production at Williamette Valley Wood Chemical Company, 1946-47.

In 1947 Joe joined The Fluor Corp. Ltd., engineers and constructors, Los Angeles. His early activities included line sizing and instrument selection for safety, measurement and control —on processes such as fluid catalytic cracking plants, thermal catalytic cracking plants, polymerization units, alkylation units, butadiene plants, crude oil separation and refining plants, natural gasoline absorption and fractionation plants, chemical plants (sulphur, cresylic, acid), and 140,000-kw steam generating plants.

As a supervisor, his duties also included the coordination and direction of instrument groups on large projects, the directing of field engineers, the checking of field installations, and the placing of instrumentation systems in operation.

A recent assignment was the supervision of the instrumentation of two butadiene plants; one for the Texas Butadiene and Chemical Corporation at Houston, Texas, and the other for the Odessa Butadiene Company in Odessa, Texas. Each plant spent in the neighborhood of a million and one-half dollars for instruments and controls plus additional instruments that were furnished with packaged units.

A "first" for Fluor and the industry was the use of a hydraulic system to operate piston-actuated gate valves on the reactors. Prior to this time, motor operated valves were used; since this innovation, all Houdry-licensed butadiene plants in construction at the present time are specifying hydraulic-operated valves.

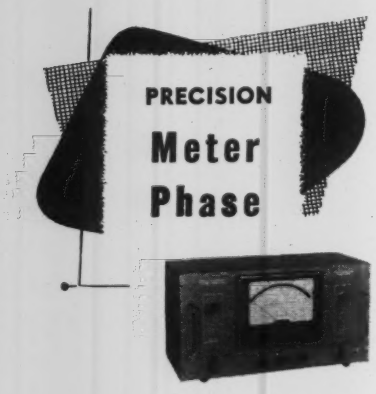
Joe has been teaching a course in Process Instrumentation at East Los Angeles Junior College, Evening Division, since Feb., 1952; which he says, "is both practical and theoretical."

The course includes:

Unit 1: Instrument Identification —symbols and letters.
Unit 2: Fundamentals—hydrostatics, pumps, heat transfer and chemical processes.
Unit 3: Pressure Measurement.
Unit 4: Thermometry.
Unit 5: Electronic Temperature Measurement.
Unit 6: Fundamentals of Automatic Control.
Unit 7: Level Measurement.
Unit 8: Control Valves.
Unit 9: Flow Measurement—orifice, pitot, Venturi, etc.
Unit 10: Relief Valves—codes, sizing.
Unit 11: Specification Writing.

In the finale (Unit 11) a typical process is instrumented and the instrument specification sheet developed.

Continued on page 2178



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For more information circle **131** on inquiry card.

BIOGRAPHIES—CONT.

Joe's present duties include (1) coordinate the instrument engineering of the proposed unit at the engineering design level with Project, Electrical and Structural Engineering, Piping Drafting, Purchasing, and Field Installation, (2) supervise Instrument Engineers in the application and writing of specification sheets, (3) train Junior Engineers, (4) inspect equipment, and (5) assist on plant start-up.

Joe is a member of the Southern California Meter Association and Mu Pi Kappa honorary engineering fraternity. He is a licensed Chemical Engineer in both Ohio and California.

Joe has authored several articles: His "Importance of Piping to Good Instrumentation" appears in this issue; "Why a Relief Valve" was published in *I&A* in June 1955, and in the *Petroleum Refiner* in July, 1955; "An Approach to the Sizing of Vapor Relieving Systems" was presented in June, 1953, at an ASME meeting in Los Angeles; "How to Figure Surge Capacity When Using Level Controllers" was published in *Petroleum Processing*, October, 1950. He also holds a Patent No. 2,697,587 (1954) on "Controlled Temperature of Multiple Cell Fan-cooled Heat Exchanger Units."

Like most of the 21 Instrument Engineers at Fluor, Joe gets his own copy of *Instruments & Automation* each month, of which he says he is a faithful reader—for many years.

Joe has been married since 1941 and says, "we have been blessed with one girl, now 6. Our daughter is a great stimulant in maintaining our enthusiasm and energy." On weekends, in particular, he has his family eating out of his hands (the reason: he is the short-order cook for breakfast, sandwiches and salads). His hobbies are photography, handball and swimming.

In order to keep abreast of our rapidly changing technology, more than half of all the 21 Instrument Engineers at Fluor attend night school, and a weekly seminar is held (on their own time) on a pertinent subject—computers, analytical instruments, etc. Other efforts are also made to keep the Instrument Engineering Department of Fluor completely up to date—for example, each time an Instrument Engineer returns from field work he discusses his experiences with the others at the weekly seminar, and the literature of the field is abstracted and discussed.

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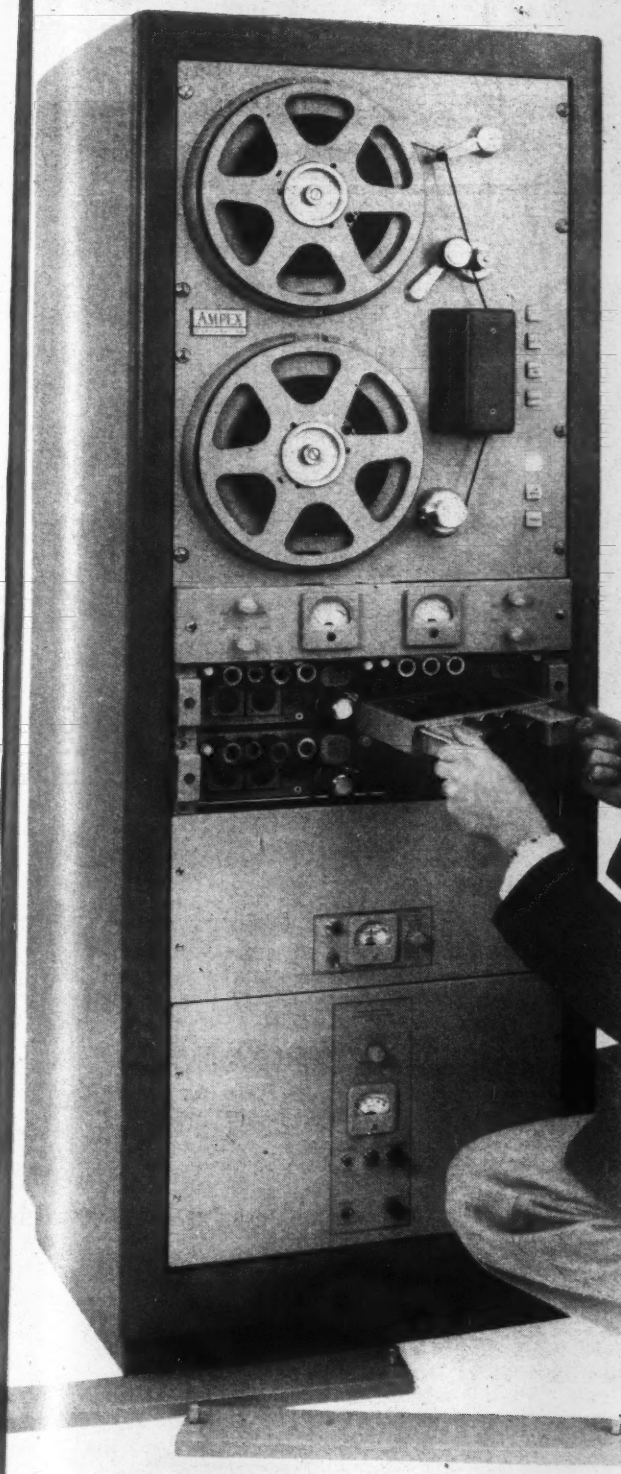
Circle **48** on inquiry card.



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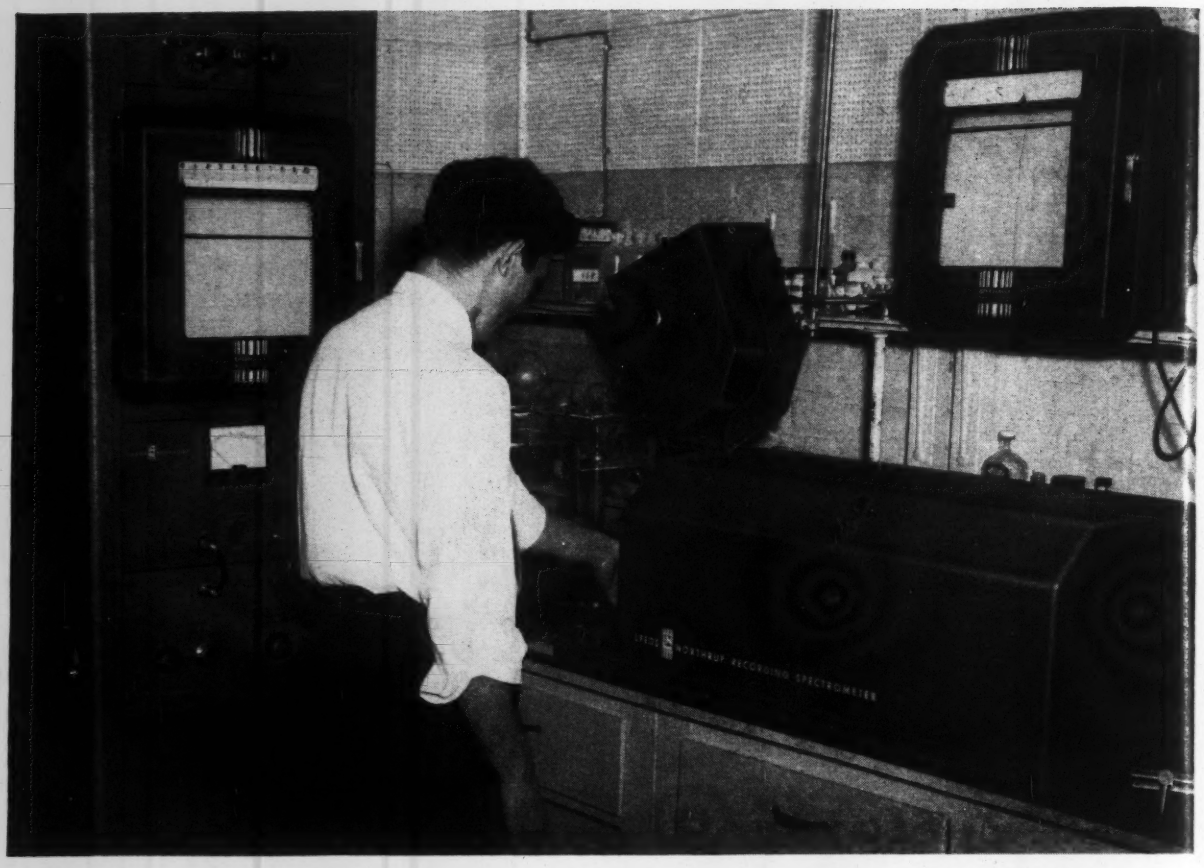

This research engineer is using an L&N Recording Spectrometer to determine hydrogen-deuterium ratios. These will be plotted on the Speedomax recorder at top left.

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Electrolytic Conductivity. L&N offers instruments for any desired electrolytic conductivity measurements. Precise laboratory measurements (overall limit of error 0.01%) are possible with the Jones Conductivity Bridge. If limits of $\pm 0.3\%$ to $\pm 1\%$ are satisfactory, you can choose from three types of portable indicators. Continuous records of laboratory experiments are plotted with Speedomax Conductivity Recorders.

Gas Analysis. Three types of gas analysis equipment are available. CO_2, SO_2, and other gases are determined with the Thermal Conductivity Analyzer. Oxygen content is accurately recorded with the Unitized O_2 Analyzer, while gas mixtures in compounds are measured with the Infrared Gas Analyzer.

An L&N application engineer will be glad to send or bring information if you give him such data as you may feel free to discuss. Address us at our nearest office, or at 4955 Stenton Avenue, Philadelphia 44, Pa.

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INSTRUMENTS and AUTOMATION

Editorial

AUTOMATION: The use of devices—mechanical, pneumatic, hydraulic, electrical and electronic—for making automatic decisions and efforts.—*M. H. Aronson*, Editor

The Effect of Automation on Productivity—Everything
The Effect of Automation on Production—Nothing
The Effect of Automation on The Economy—Meaningless

THE entire instrument industry is falling into a trap, carefully laid and perfectly disguised with attractive lures—but one which portends dangerous consequences.

The trap is being laid by conferences and investigations and articles and speeches on "the effect of automation on our economy."

Every word spoken on this subject implies that automation can cause or harm or otherwise affect the economic health of our country. Every conference arranged on this subject establishes these implications more deeply in more minds—and congressional investigation of this subject propagates this inference throughout the nation into every home via mass media of communication. The lure in this case is publicity—every instrument manufacturer, every editor, every "name" in the field sees an opportunity for wide publicity. But what will our industry do when a recession or depression strikes? Will we then plan and run to more conferences on "the effect of automation on our economy"? Our industry is being set up like a sitting duck; we are helping to make ourselves scapegoats for possibly catastrophic national troubles of the future. Even worse, we may be helping to bring on economic trouble by sidetracking much-needed analyses of our economy.

Consider the evidence. Automation is a technique for increasing productivity—not production. Productivity and production are entirely unrelated—*one can and does increase while the other decreases.*

Productivity Statistics

Examination of *productivity figures* as reported by the Bureau of Labor Statistics shows annual average *increase* of 5.3% in productivity in the decade 1919-1929; 2.2% annual *increase* from 1929-1939; 3.4% annual *increase* from 1947-1953. (The figures between 1939-1947 are affected because of abnormal wartime conditions.) The present rate of productivity increase is about 3% per year.

Production Statistics

Production figures for these same years show erratic trends, with precipitous *declines* in certain years, such as between 1929-1933. In every year there are industries whose production decreases—while productivity increases.

Conclusions

The important point here is the effect, or lack of it, of productivity on production—and vice versa. Leon Greenburg of the Bureau of Labor Statistics said in a speech of June 21, 1956 at a conference on Economic Growth at Dartmouth College: "The evidence is not overwhelming, but it suggests some cyclical relationship between volume of output and productivity in manufacturing . . . it has not been firmly established which one is the dependent and which the independent variable . . . it also suggests the presence of some other factors with an *almost relentless influence* (italics ours) on the trends of productivity in manufacturing."

We suggest that the evidence is overwhelming, that the cyclical "relationship" between volume of output and productivity is of a minor nature indeed, but that a gross relationship is obvious and inescapable. This is, simply, that *productivity gain is obviously relentless and irresistible* because ours is a free-enterprise capitalistic society in which nobody in his right mind would produce anything by methods less efficient than are available to his competitors. By its very nature, productivity must increase by some amount, small or large, year after year, good times or bad times.

Production indexes, however, reflect the health of the economy as a whole. When market demand is high, production will increase; when markets shrink, production will fall.

This distinction between the relentless and irresistible factor of productivity and the entirely unrelated factor of production—which is neither relentless nor irresistible—destroys the logical basis for any discussion of the "economic effects of automation." Such discussions imply that productivity is a causal factor influencing production. This is not true. The *facts* prove that it is not true. Anybody interested in the subject of the economic health of the country wastes his time in an examination of automation for two reasons: (1) When the automation device becomes economic it *must be used* by the entrepreneur in a free competitive society, which is why productivity must always increase—but (2) the major factors that establish the total production and economic health of a nation include wages, prices, interest rates, income tax rates, federal expenditures, business investments, and the many other factors that together establish the purchasing power of a populace. Hence productivity must always increase; production can increase or decrease rapidly, at any time. Having proved by both logic and statistics that productivity (automation) has little effect on and absolutely no causal relationship to production totals (economic health), we predict more conferences and investigations on the "effect of automation on our economy." This publicity may be "irresistible and relentless"—but the evil effects of this subversion of economic facts can be harmful to our industry. Let us weigh the value of all such discussion and investigation in the light of possible future implications. ***MHA***

Figures Vs Facts

An article in the McGraw-Hill publication *Business Week* of July 28, "From Boom to Steady Growth," characterized the instrument industry as having "recession symptoms" and described it as "Sales Falling and Profits Falling Faster."

As this is completely at variance with our many analyses of the economic condition of the instrument industry, we made a special survey of 3674 companies on our list of companies manufacturing products used in the instrumentation-automation field. 756 companies (21%) answered our questionnaire. Of these, 262 (35%) showed rising profits; 355 (47%) steady profits; and only 112 (15%) falling profits—and most of these latter are smaller firms, as shown in the table. Our industry has no recession symptoms and enjoys rising sales and steady profits, generally.

No. of Employees	Sales Increasing			Sales Steady			Sales Falling			
	Profits Rising	Steady	Falling	Profits Rising	Steady	Falling	Profits Rising	Steady	Falling	
Under 15	64	43	1	2	40	7	0	0	18	175
15-50	52	48	6	1	40	16	0	1	17	181
51-150	49	50	4	0	21	7	0	1	10	142
151-500	51	43	5	0	22	4	0	1	7	133
501-1000	18	18	1	0	5	2	0	0	1	45
1001-2500	13	11	1	0	1	1	0	0	1	28
Over 2500	10	6	3	2	4	0	0	0	0	25
TOTAL	257	219	21	5	133	37	0	3	54	729

Not filled out completely: 27
Total returned: 756

Automation—An International Theme

Observers from Russia, Czechoslovakia, England, France, Italy and other countries abroad are giving headaches to State Department personnel in their attempts to attend the Third International Automation Exposition, to be held Nov. 26-30, 1956 (Automation Week in New York City). The TIAE has several unique features that are of importance to both foreign and American observers—(1) the range of exhibits encompasses all phases of automation—office automation, process automation, plant automation, laboratory automation, (2) several hundred clinic classes will be held on all modern automation techniques—pneumatic, hydraulic, electric, electronic, mechanical, and optical, (3) the array of data handling and computing equipments to be exhibited exceeds any previous exhibitions of such equipments, anywhere, (4) many first disclosures are planned to coincide with the Exposition, (5) the National Simulation Council will meet in conjunction with the TIAE, and (6) high-level symposia will be held on the subjects of "Office Automation" and "Human Engineering." These plus other automation events (the annual meeting of the American Society of Mechanical Engineers will be held on the same dates in New York City) will make New York City the center of attention for the automation world for the week of Nov. 26-30.

Of all these exciting features, the one with the greatest educational implications is the clinic-class feature. Every clinic principal plans to give a basic education in the technology associated with the equipment, plus practical applications instruction.

The following outlines will give you an idea of the tremendous educational value of such sessions. Note that several of these clinic classes have been scheduled at the last minute, so you still have an opportunity to get in on the ground floor (several are already sold out). The last-minute classes include (1) Quarie Controllers, who will lecture on the implications and applications of optimal control, perhaps one of the most important concepts of today (2) The Burroughs Corp., who will lecture on the exciting E-101 digital computer which features easy-to-learn pinboard programming, as all class registrants will see for themselves. (3) Miniature Precision Bearings, who will lecture on use of miniature ball bearings, including cleanliness factors, assembly, etc. (4) Design Tool Corporation, who will lecture on automatic handling and preparation of electronic components.

Dear D.R.*:

The front cover this month shows two exciting new developments—and both are exclusives for you dear D.R.'s. of *I&A*. Better than that, both will be lectured about at the Automation Exposition—and both represent dramatic new techniques with possibilities yet untapped. If you want to hear more about these new technologies—or about high-speed photography (Wollensak) or the fabulous DATRACs (Epsco) or any of the exciting things offered to you on the following pages—telephone or wire today for your clinic registration. Several of the clinic classes outlined on the following pages are nearly all sold out, so wire or telephone your registration today. Six of these classes would be a bargain at $100—and they cost only $10. Note that the clinic sessions of Quarie and Burroughs have just been announced.

As to the significance of these exclusive disclosures, the 500-million-bit RAM of Potter Instrument will be the most exciting data-handling news in a long time. In addition to the data-handling implications (this opens new frontiers to almost all aspects of data handling, from bank accounts to refinery distillation), the RAM features a digital positioner that will stimulate the imagination of process men, who are always looking for better valve positioners.

Great ideas seem to occur simultaneously. In No. 13 of the Digital Automation Series by M. K., F. W., and H. M. (see pages 2205-07), the flexibility of digital control techniques as applied to fluid ratio and servo problems is discussed—and you will find that the digital valve positioner appears here also. This new concept should be examined closely—the power of the cylinder positioner plus the accuracy of digital techniques presents another dimension to the valve actuator scene.

The second exciting disclosure in the feature articles this month is Optimal Control. The Quarie Optimal Controller permits you to apply some concepts that previously were just exciting possibilities. Byron White will be lecturing on the techniques and its application in room 409 at the Automation Exposition, so you can follow this

*Dear Reader

idea up quickly—but you better wire or telephone your registration.

Peter Morris of the National Lead Company of Ohio searched all the literature of the field—no mean task—and found just one reference to the problem of checking a thermocouple (Alex Sherman, *Instruments & Automation*, Jan., 1954).

Imagine that—just one reference to the obviously basic problem of checking a thermocouple, perhaps the single most important temperature measuring device in industry. So we rushed his article into print; in fact, we had to postpone our Electronic Circuitry feature this month in order to bring you his "Inductance-type Thermocouple Tester." Now there are two references in the literature.

Chet Beard's article on "Valve Sizing" this month (pages 2220-23) wraps up the many different factors that must be considered in a neat package. The many details have confused many instrument men—this article will re-orient them.

There are also many new ideas about lubrication in the article "Solid Film Lubricants" on pages 2232-36.

All this adds up to heavy issue—heavy in ideas and education—and we hope it finds you well and happy this month.

Cordially,
Milt and the Editors.

Detailed Outlines of a Few of the Clinic Classes

Automatic Handling & Preparation of Electronic Components (*Design Tool Corporation*)

Feeding Mechanisms; Tape Striping, Card Feeds, Hoppers.
Component Preparation: Lead straightening, lead cutting & bending, lead cutting & forming.
Automatic Positioning: printed boards, drilling holes, inserting eyelets or terminals, inserting sockets

Recent Data-handling and Digital Developments (*Potter Instrument Co.*)

The RAM—a 500-million-bit random access memory
Magnistors—basic storage and decision elements
The Magnityper—magnistorized version of the "flying typewriter."
A new "bin" sorter
Developments in high-speed digital tape handlers

Data Handling in the Process Industries (*Panellit*)

Set pots, Selector Modules, Alarm memory modules.
Programmers
Measurement features (automatic range change, analog-digital conversion)
Storage Relays, Pulse Generators.
Digital Clock and Timer
Maintenance Features
Scanning, Outputs, Charts and Formats
Tape Punch, Readout, Tie in with IBM and other equipments
Typical applications

The Rotameter—a flow element for automation systems (*Brooks Rotameter Co.*)

Principles and flow fundamentals
Electronic signalling equipment (transmitters)
Sizing
Flow system considerations

Ultrasonic Techniques for Industry (*Branson Ultrasonic Corp.*)

Ultrasonic gaging
Transducers
Frequency ranges and considerations
Precision gaging
Corrosion surveys
Concentricity
Laminar flaws
Ultrasonic Cleaning
Methods of power generation and transmission
Selection of solvents and detergents
Standards of cleanliness
Typical applications

TV Data Transportation Systems (*Jerrold Electronics Corp.*)

TV and wide-band data transportation systems, single and multi-channel
One way and 2-way systems for small areas and large areas
System engineering, including control circuits on coaxial cable.

Machine Tool Automation (*Hillyer Instrument Company*)

Automation Locating and Drilling Machines
Multiple Channel Programmers

Servomechanisms Clinic (*PIC Design*)

Fits and tolerances for standardization
AGMA Standards, ABEC Standards.
MIL Finishes, MIL Lubrications
Importance of fine pitch gears
Instruments for pitch dia., tooth and tooth error, bore dia. and finish, concentricity, wobble, finish, etc.
Advantages of standardization

Control of Dust, Debris, and Foreign Matter in Precision Assembly (*The Baker Co.*)

Composition of dust
Mechanical filters
Electrostatic precipitators
Room material factors
White rooms and benches
Special clothing and cleaners
Enclosed areas
Conveyor belts and tote boxes
Ultrasonic cleaning
How clean is clean (Air Pollution measurement)
Economic factors

Automatic Accumulation and Reduction of Test Data with Application to Statistical Quality Control (*Electronic Control Systems, Inc.*)

Terminology and techniques for quality control—average, standard deviation, range, and sample size
Application to inspection
The Histogram
Automatic plotting of a bar Histogram
The Statistical Analyzer (principles and applications)
Accessories
Typical applications—production testing, quality control, process control, etc.

Path Control Systems for Machine Tools (*Electronic Control Systems, Inc.*)

Transferral of data from blueprint to computer
Control of cutter and workpiece paths
Complex contours
Economics and advantages

The equipment: Machine tool, Control unit, Computer, Planning desk.
Examples of problem preparation and use

Controlled Production with Controlled Fluid Power (*Modernair Corporation*)
Automatic Cycle Control
Control of Ore Bin Gates
Flexibility of Coaxial air-hydraulic cylinder circuits
Manual and automatic oscillation of air circuits
Automatic clamping, work stroke and return
Portable fluid-power units

Selective Data Printers (*Copy-Craft*)
Line selection for production control
Supplementary use with data processing machines
Unit media tickets for accounting machine
Use in the USAF
Use as supplement to End-Product of other machines
Preparation of Ormig masters
Typical applications to date

COC Automation—Off the Shelf (*Hammarlund Mfg. Co.*)
Principles of remote control via audio tone frequency
Carriers (telephones, wires, radio links)
Standard elements—transmitters, receivers.
System build-up and test

High-Speed Photography (*Wollensak*)
Techniques for photography at 16,000 frames/sec.
Simultaneous recording of oscilloscope Traces and visual phenomena
How the camera works
Applications and accessories.

Automatic Gaging, Inspection and Size Control (*Airborne Instruments Laboratory*)
Comparison of methods (air gages, switch-type gages, electronic gages)
Accessories: Head mounts, Gaging stands.
Bench-type measurements
Semi-automatic sorting of parts
Completely automatic inspection and sorting.
Special measurements.
Automatic control applications
Selection between aftergaging and in-process gaging
Applications of aftergaging and in-process gaging

List Of All Clinic Classes

ELECTRONIC, HYDRAULIC, PNEUMATIC AND ELECTROMECHANICAL TECHNIQUES

Analyzing applications for pneumatic and hydraulic equipment in automatic operations.
Presented by Modernair Corp., in Room 343

Ultrasonic techniques for gaging, inspection, flaw detection, and cleaning.
Presented by Branson Ultrasonic Corp., in Room 548

Application of scopes and scanners to automatic control systems, e.g. flaw detection in continuous processing.
Presented by Allen B. Du Mont Labs., in Room 339

Characteristics and applications of syncroverters, choppers and high-speed relays in automation.
Presented by Bristol Company, in Room 301

TV and wide-band data transportation and distribution systems, and remote control equipment.
Presented by Jerrold Electronics Corp., in Room 407

ANALOG COMPUTERS

Special-purpose analog computers for control of machine tools, rolling mill schedules, motor lamination production, and other specific industrial applications—includes analyzing the problem and determining the most effective computer approach—analog or digital.
Presented by Austin Company, in Room 553

Simulation and computation with the general-purpose analog computer, including practical applications on specific problems already solved—also new developments in automatic programming, setup, and checking—also new special-purpose digital computers.
Presented by Berkeley Division, Beckman Instruments, Inc., in Room 328

Setting up specific problems on the general-purpose analog computer, with emphasis on use of each element of the computer.
Presented by Electronic Associates, Inc., in Room 349

High-speed analog-to-digital conversion and data handling, featuring "DATRACS" 200,000 Conversions per second—emphasizing data sampling, band width, noise, etc.
Presented by Epsco, Inc., in Room 416

Simulation—the modern way to high-speed analysis of design, operation, and control of equipment.
Presented by Intercontinental Dynamics Corp., in Room 427

Operation and application of the general-purpose analog computer, with discussion of practical solutions for typical aircraft, process, and tunnel applications.
Presented by Reeves Instrument Corporation, in Room 333

DIGITAL COMPUTERS

The E-101 general-purpose digital computer, featuring pinboard programming.
Presented by The Burroughs Corporation, in Room 447

New G-15D general purpose computer with a digital differential analyzer accessory.
Presented by Bendix Aviation, Computer Div., in Room 424

Introduction to the design, use, and operation of the general-purpose digital computer, including interlace data recording on magnetic storage drums—a feature of the new LGP-30 digital computer.
Presented by Royal McBee (Librascope), in Room 325

New applications for large-scale electronic digital computer in office and engineering automation—equipments range from small card punches to giant "UNIVAC" systems.
Presented by Remington Rand Div., Sperry Rand Corp., in Room 534, 537

Use of universal building blocks in the logical design of digital computers, including binary arithmetic and symbolic logic.
Presented by Computer Control Company, in Room 419

Alternative methods of presenting and recording digital computer results, with advantages of each—also a brand new random access memory for high-capacity storage.
Presented by Potter Instrument Co., in Room 549

High-speed analog-to-digital conversion and data handling, featuring "DATRACS" 200,000 Conversions per second—emphasis on data sampling, band width, noise, etc.
Presented by Epsco, Inc., in Room 416

Special-purpose computers for control of machine tools, rolling mill schedules, motor lamination production—many other specific applications.
Presented by Austin Company, in Room 553

PROCESS AUTOMATION

COC (Centralized Operation Control) techniques, with demonstrations of systems built up from COC subsystem elements.
Presented by Hammarlund Manufacturing Company, in Room 551

Control application of "Dynamaster" high-speed potentiometer equipment.
Presented by The Bristol Company, in Room 301

Automatic control systems for process variables, including load, pressure, torque, etc.
Presented by Baldwin-Lima-Hamilton Corp., in Room 542

Rotameter" flow measurement and control.
Presented by Brooks Rotameter Company, in Room 532

Optimal process control—a new technique for control of a process at a given point on the process reaction curve. *Presented by Quarie Controllers, in Room* 409

Installation and operation of centralized control of integrated, remote, field operations.
Presented by Panellit, Inc., in Rooms 529, 530

Selection and application criteria for pressure switches.
Presented by Gorn Electric Co., Inc. in Room 544

Investigation of valve system performance factors, e.g. capacity, erosion, tight shut-off, and high-speed operation; with description of Paul Venturi Ball Control Valve.
Presented by P-K Industries, Inc., in Room 526

AUTOMATIC PRODUCTION, ASSEMBLY, CLEANING AND FABRICATION

Automatic work positioning, drilling, machining—a frontier of automation—learn how to apply it to your machine tools. *Presented by Hillyer Instrument Co., in Room* 520

"Digimatic" control systems for machine tools—featuring tape-recorded control data.
Presented by Electronic Control Systems, Inc., in Room 507

Special and standard gaging and control systems and components for machine tools.
Presented by Airborne Instruments Labs., in Room 302

Automatic transfer machines, conveying equipment and automatic production machines.
Presented by Aard Equipment Company, in Room 405

COC (Centralized Operations Control) systems built up from COC subsystem elements—many practical examples.
Presented by Hammarlund Manufacturing Co., in Room 551

Automatic transfer and conveying equipment—automatic warehousing.
Presented by Gaudreau-Rimbach Associates, in Room 402

Work center systems for efficient production and assembly. *Presented by Alden Systems Company, in Room* 321

Dust control for precision assembly—sterile atmospheres.
Presented by Baker Company, Inc., in Room 408

Ultrasonic techniques for cleaning, gaging, inspection.
Presented by Branson Ultransonic Corp., in Room 548

Component cleaning—with live demonstrations of automatic cleaning equipment.
Presented by Cobehn, Inc., in Room 531

Automatic control units for positioning of machine tools with tape, card or pre-set programming.
Presented by Warner & Swasey Research Corp., in Room 329

Facilities and methods used to insure cleanlines of miniature instrument ball bearings.
Presented by Miniature Precision Bearings, Inc., in Room 540

Automatic handling and preparation of electronic components—feeding mechanisms, component preparation, printed boards, etc. *Presented by Design Tool Corporation*

OPTICAL TECHNIQUES

High-speed photography—principles, techniques, and applications. Learn the new techniques made possible with high-speed photography.
Presented by Wollensak Optical Company, in Room 518

Close-up, copywork and microscopic photography applications—emphasizing techniques.
Presented by Karl Heitz, Inc., in Room 505

Industrial television with vari-focal optics.
Presented by Zoomar, Inc., in Room 320

SERVOMECHANISMS

Factors in selection of electromechanical components, including standardization of differentials, speed reducers, gears, etc. *Presented by PIC Design Corp., in Room* 554

Integration of servomechanism subsystems—defining the extent of subsystem design units.
Presented by Servomechanisms, Inc., in Room 525

Working-model demonstrations of principles, components and applications of servomechanisms.
Presented by Servo Systems Company, in Room 414

OFFICE AUTOMATION AND DATA-HANDLING

Large-scale office procedures and systems implemented by automatic data processing machines.
Presented by Remington Rand Div., Sperry Rand Corp., in Rooms 534, 537

Special-purpose "Magnetronic" systems for automatic banking, automatic reservation handling, automatic stock exchanges, automatic inventory, etc.
Presented by Teleregister Corporation, in Room 436

Large-scale data handling for industry and finance, including point-of-action data pick-up and media transfer systems. *Presented by Underwood Corporation, in Room* 429

Applications for semi-automatic and fully automatic pneumatic tube systems for transferring data and documents, including demonstrations of operating systems.
Presented by International Standard Trading Corporation, in Room 527

Ormig selective data printers, which break down data from lists and print on single-item tickets, also select and print lines, columns, headings.
Presented by Copy-Craft, Inc., in Room 327

Digital data recording and handling, including a new random-access memory of high capacity for business applications.
Presented by Potter Instrument Company, Inc., in Room 549

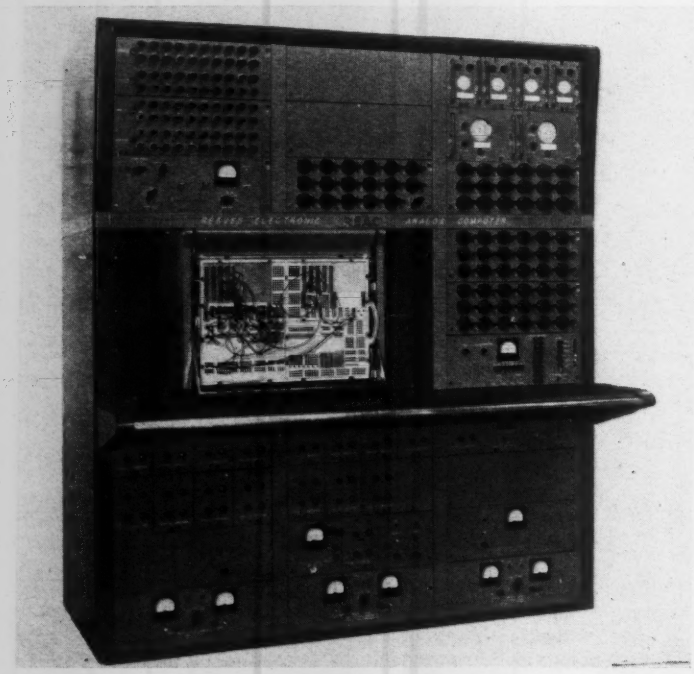
Automatic data logging and control centers for industrial operations. *Presented by Panellit, Inc., in Rooms* 529, 530

Automatic production testing, incoming inspection and automatic acceleration of statistical data for statistical quality control.
Presented by Electronic Control Systems, Inc., in Room 507

THE THIRD INTERNATIONAL AUTOMATION EXPOSITION

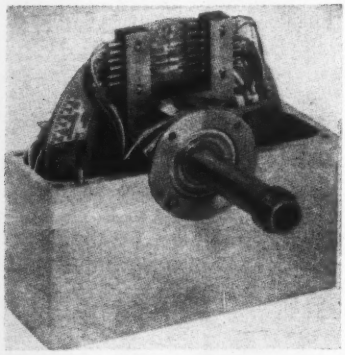
New Product Preview

Here are a few of the many automation devices that will be exhibited at the Third International Automation Exposition, New York Trade Show Bldg., Nov. 26-30 (Automation Week in New York City by proclamation of the Mayor of New York City). The items marked by star will also be demonstrated and taught in 90-minute lecture-demonstration clinic classes. For details on the clinic classes, see pages 2182-2184.



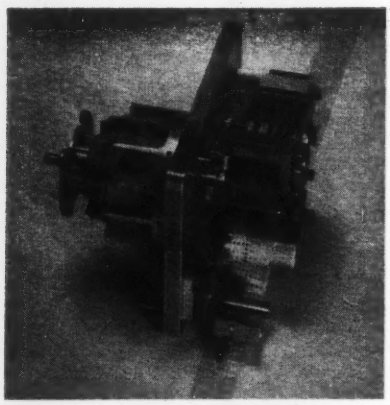
★ Reeves Instrument Corp. will feature three new REAC analog-computer developments: A time scale check as a supplement to the problem check system; a six-channel recorder for checking mechanical and electrical zero, also attenuation setting for each channel before starting computer; and size 11 resolver with 0.1% functional accuracy.

For more information circle **601** on inquiry card.



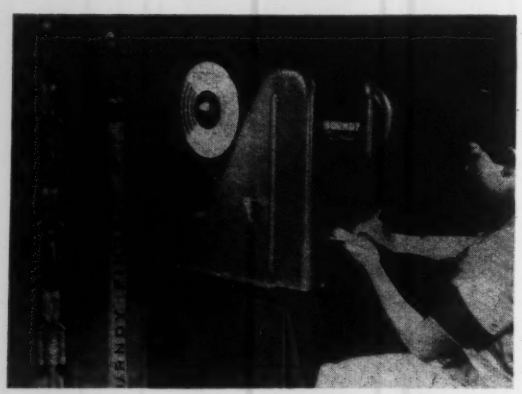
Wang Laboratories, Inc. will show their analog-to-digital converter.

For more information circle **602** on inquiry card.



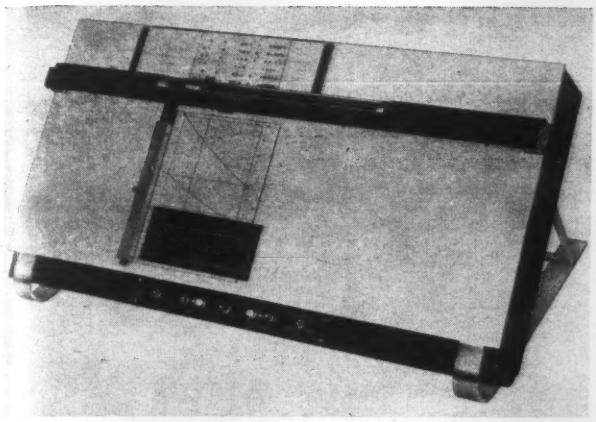
Soroban Engineering's high-speed tape perforator Model GP-100 is a motor driven unit for punching holes as standardized by the communications industry.

For more information circle **603** on inquiry card.



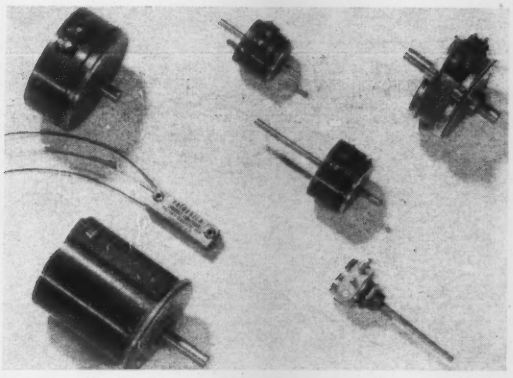
Burndy Engineering Co., Inc., has developed an automatic machine for the terminating of FINGRIPS, continuous strip terminals. The TERMINATIC will have its unveiling at the TIAE.

For more information circle **604** on inquiry card.



The Gerber Equameter which produces equations of curves in terms of Fourier series, power series, or least squares is the latest development of the Gerber Scientific Instrument Co. which will be displayed with the Graphanalogue, a variable scale, and a Derivimeter.

For more information circle **605** on inquiry card.

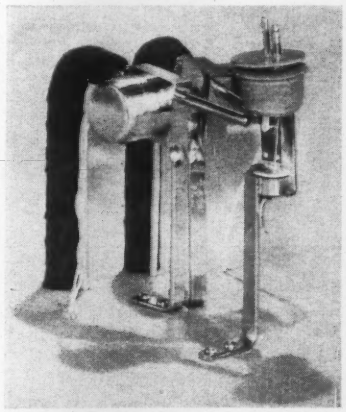


Fairchild Controls Corp., Component Div., has a new line of precision potentiometers and components for operating temperatures from —55 to plus 225° C, which include single and multi-turn types. They will be the company's "firsts" at the Exposition.

For more information circle **606** on inquiry card.

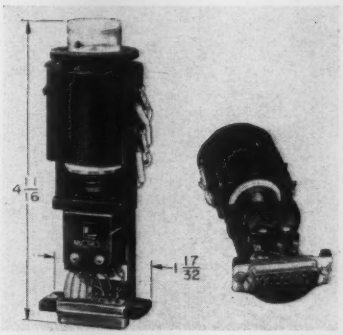
Zenith Electric Co.,'s new 24-hour repeat cycle timer permits scheduling of up to 48 "on-off" operations.

For more information circle **607** on inquiry card.



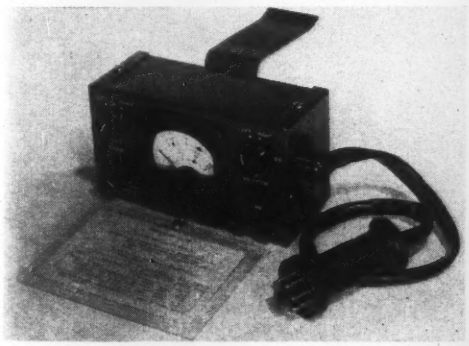
★ Cobehn, Inc., will display its latest development—automatic, rotary, solenoid controlled spray guns for production line cleaning of instrument bearings, jewel bearings, electrical contacts, semiconductors and other precision components.

For more information circle **608** on inquiry card.



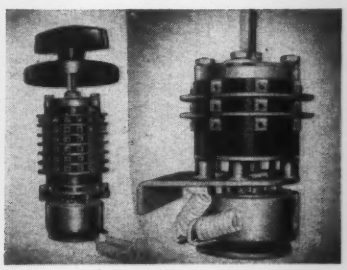
Micro Switch, Div. of Minneapolis-Honeywell will unveil an alternate-action, 3-light pushbutton switch with connector base.

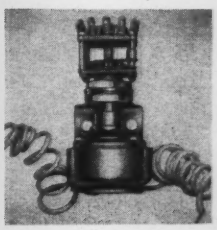
For more information circle **609** on inquiry card.



★ Hammerlund Manufacturing Co. will exhibit the new TM-I test meter, which permits maintenance and trouble shooting of the company's complete control system by non-technical personnel.

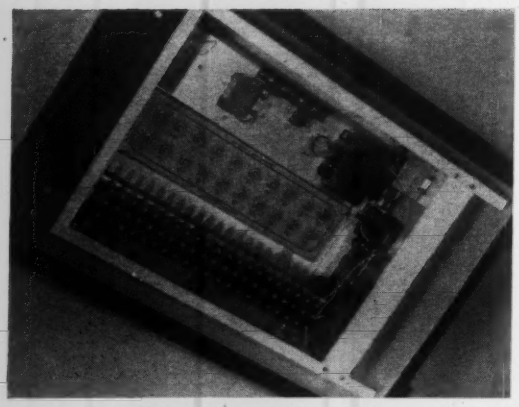
For more information circle **610** on inquiry card.





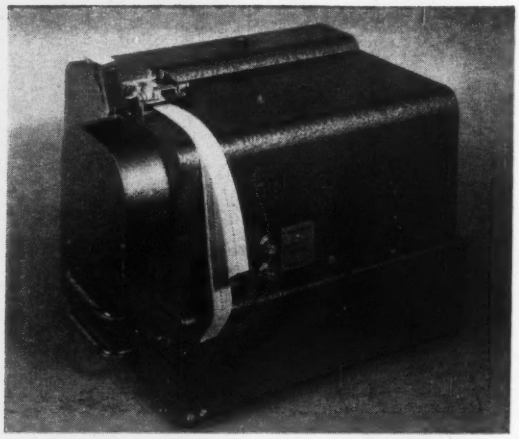
Solenoid-operated rotary multipole switches, ESCO Types JR, HT, and RF Electronics M-12 (subminiature), respectively, will have their first showing at the Electro Switch Corp. display.

For more information circle **611** on inquiry card.

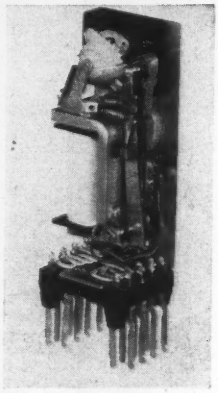


The Cat. 200 Timed Operations Preselector which will be shown by Henry G. Dietz Co. is a time control device with independent multiple contacts operated individually for any single interval of a group of adjustable multiple intervals.

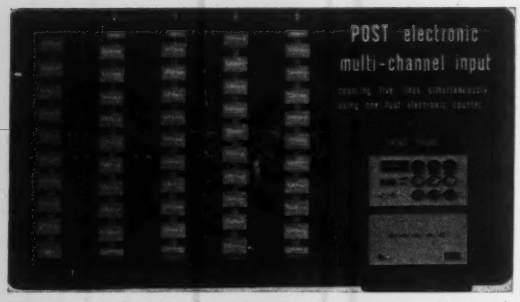
For more information circle **612** on inquiry card.



★ International Standard Trading Corp. will show a 12-point high speed stepping relay (made in Belgium) and a high speed reperforator, Model 25, manufactured by Creed & Co., Croydon, England.

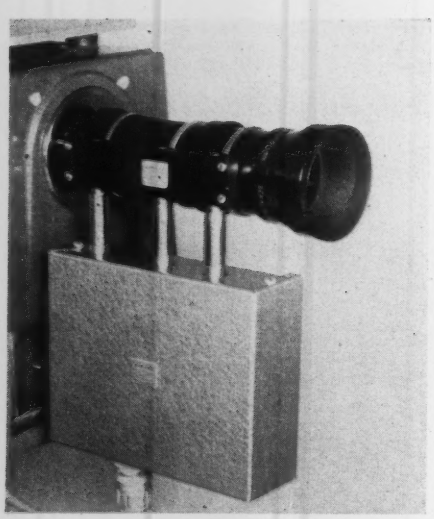


For more information circle **613** on inquiry card.



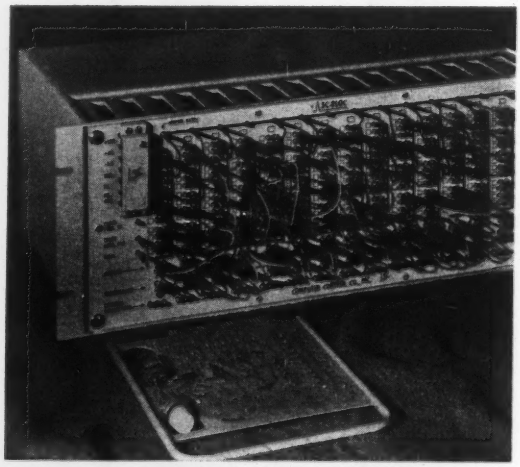
Type MC multi-channel input electronic counter, with anti-coincidence feature, can count simultaneously production of five lines. Exhibited by the Electronic Products Div. of the Post Machinery Co.

For more information circle **614** on inquiry card.



★ Remotely controlled TV cameras for industrial applications, equipped with Zoomar lenses will be the featured new products in the exhibit of Zoomar, Inc.

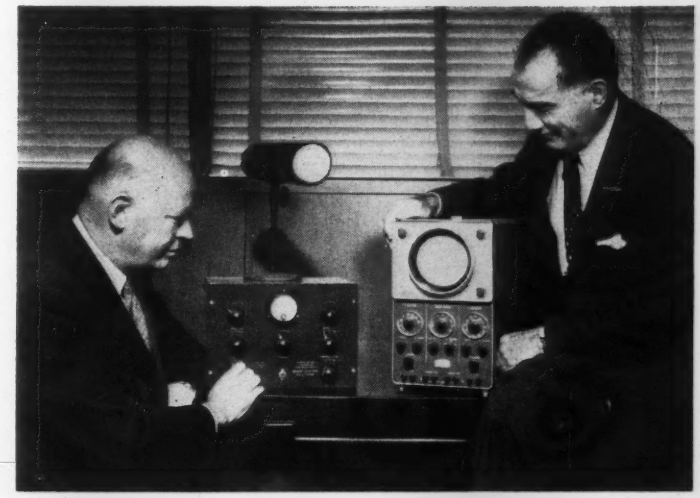
For more information circle **615** on inquiry card.



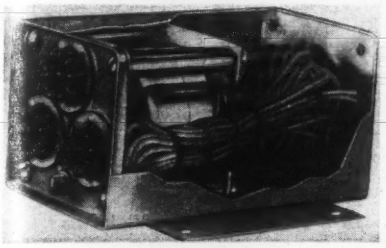
★ Computer Control Co., Inc. will show transistorized low speed computer packages (not illustrated), plus its 3C-Bloc and 3C-PAC digital building blocks (see picture). Their clinic session will teach logical design of digital computers, binary arithmetic and symbolic logic.

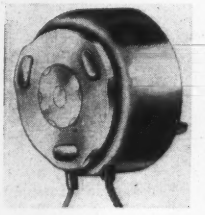
For more information circle **616** on inquiry card.

Oil-tight indicator lights are the latest development of the Dialight Corp.
Circle **617** on inquiry card.

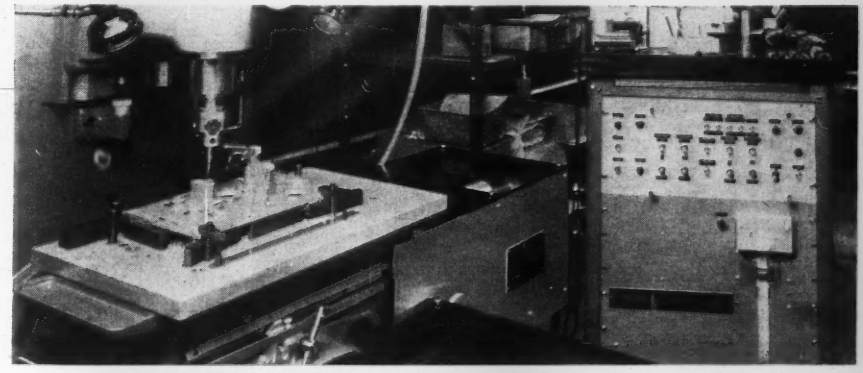


DuMont's elite "400" series—the Type 401 Cathode-Ray Oscillograph is compared with the first oscillograph model developed twenty-five years ago by Dr. Allen B. DuMont (left). David T. Schultz, Pres., views the first of the elite "400" series.
For more information circle **618** on inquiry card.

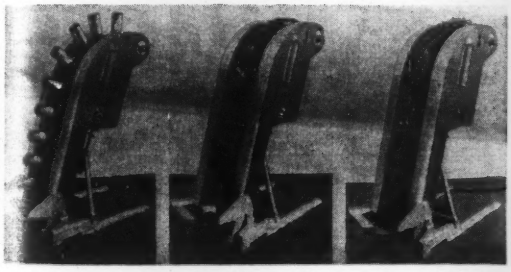




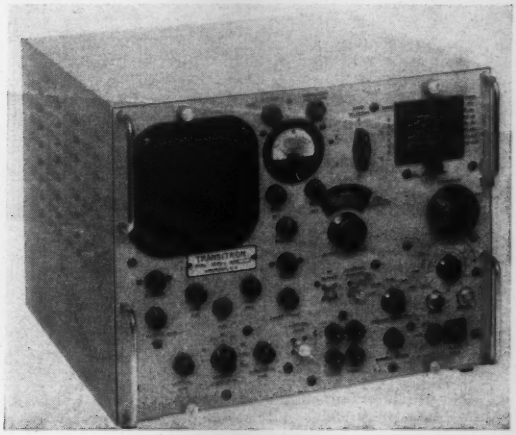
Model BIDE, a 1"-dia. rotary solenoid, and hermetically sealed, moisture and dust proof rotary selector switches and stepping relays are the new products G. H. Leland, Inc. has prepared for first showing at the Exposition.
For more information circle **619** on inquiry card.



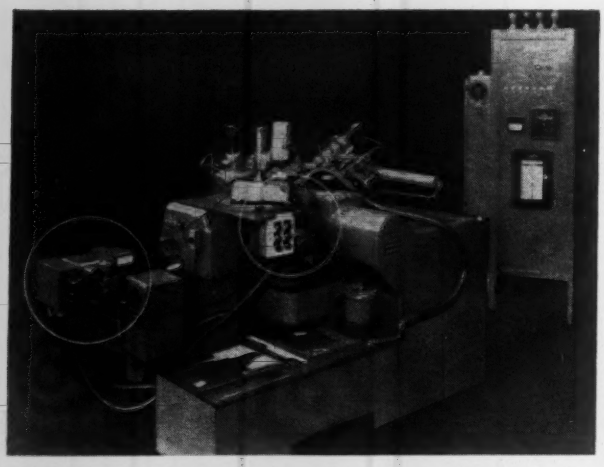
★ "PROBAMAT" automatic positioning system for jig borers can be operated by tape, card or the company's PRE-SET system. Displayed by The Warner & Swasey Research Corp., leaders in machine-tool automation, who will conduct a clinic class on machine-tool automation.
For more information circle **620** on inquiry card.



Eriez Manufacturing Co., will demonstrate its new MAGNA-MOVER and MAGNA-RAIL magnetic conveyor units.
For more information circle **621** on inquiry card.

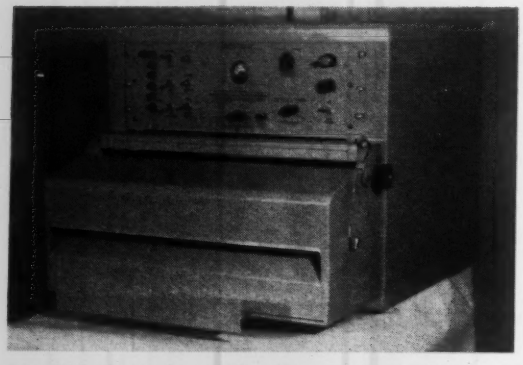


Transitron, Inc. will feature the Model SG-132 precision VHF-UHF electronic-sweep signal generator.
For more information circle **622** on inquiry card.



The Kaydon Engineering Corp., will feature their "Size-O-Tron" automatic gaging and size control unit for through feed centerless grinders, finished work is continuously gaged from the machine and the information is fed back to the machine automatically adjusting for wheel wear and other variables.

For more information circle **623** on inquiry card.



L&O Research and Development Corp. will feature their new "Model 956-B" flat copy continuous scanning facsimile transmitter.

For more information circle **624** on inquiry card.

International Business Machines Corp. will feature their APR automatic production recording system designed to collect, correlate, store and record production data automatically from various measuring instruments.

For more information circle **625** on inquiry card.

OTHER NEW PRODUCTS AT TIAE

(Starred items will be subjects of clinic classes)

★ **Teleregister Corp.** will unveil a completely integrated, automatic savings account system, specifically designed to meet problems faced by banks and lending institutions.

For more information circle **626** on inquiry card.

Bell Automation Corp. will present a new electronic continuous weighing system.

For more information circle **627** on inquiry card.

★ **Panellit, Inc.**, will display a new series "40" Motorlarm Annunciator, a package motor signaling system designed to tell instantly which motors are running, which are stopped, and which are manually shut down.

For more information circle **628** on inquiry card.

The newest products of **Condenser Products Div.**, New Haven Clock and Watch Co., are high-temperature teflon capacitors, good up to 200° C.

For more information circle **629** on inquiry card.

Electro-Tech Equipment Company, distributors of the Alkon line will have new type air cylinders on display.

For more information circle **630** on inquiry card.

Maser Oscillator for frequency standards will be featured at the **Standard Electronics Research Corp.** booth.

For more information circle **631** on inquiry card.

★ **Bendix Computer Div.** will present its new G-15D combined general purpose computer and digital differential analyzer.

For more information circle **632** on inquiry card.

★ **The Bristol Company** will bring an array of new products to the show. Among them are: A remote positioning system for control of secondary control surface on aircraft; a new pressure switch; an electronic transducer; also a miniature recording potentiometer recording on a three-inch strip chart with plug-in chassis.

For more information circle **633** on inquiry card.

★ Ultrasonics instrument ball bearing assembly tool sets, Models GW-4 and GW-5, new ball bearing torque testers, and the Baker Steril-shield dust-free work benches will be the feature presentations of **The Baker Co., Inc.**

For more information circle **634** on inquiry card.

★ On display at the **ElectroData** booth will be the new Model E101 desk-size electronic digital computer.

For more information circle **635** on inquiry card.

★ A high-speed 16-mm motion picture camera, the FASTAIR, specifically designed for recording flight characteristics of guided missiles has many industrial applications. This is the new product **Wollensak Optical Co.** will show.

For more information circle **636** on inquiry card.

The new PAK-RAPID machine is fully automated to produce flexible air-evacuated packages. It will be shown in operation by **Pak-Rapid, Inc.**

For more information circle **637** on inquiry card.

★ **PIC Design Corp.**, now a Division of Benrus Watch Co., will show its line of precision instrument parts which has been increased to 3000 by the merger. All standard parts are stocked for immediate delivery.

For more information circle **638** on inquiry card.

Reeves Soundcraft Corp. will display its new Type "A" instrumentation tape, designed specifically for data processing.

For more information circle **639** on inquiry card.

Midwestern Instruments will show its new extremely shock resistant 560-B oscillograph.

For more information circle **640** on inquiry card.

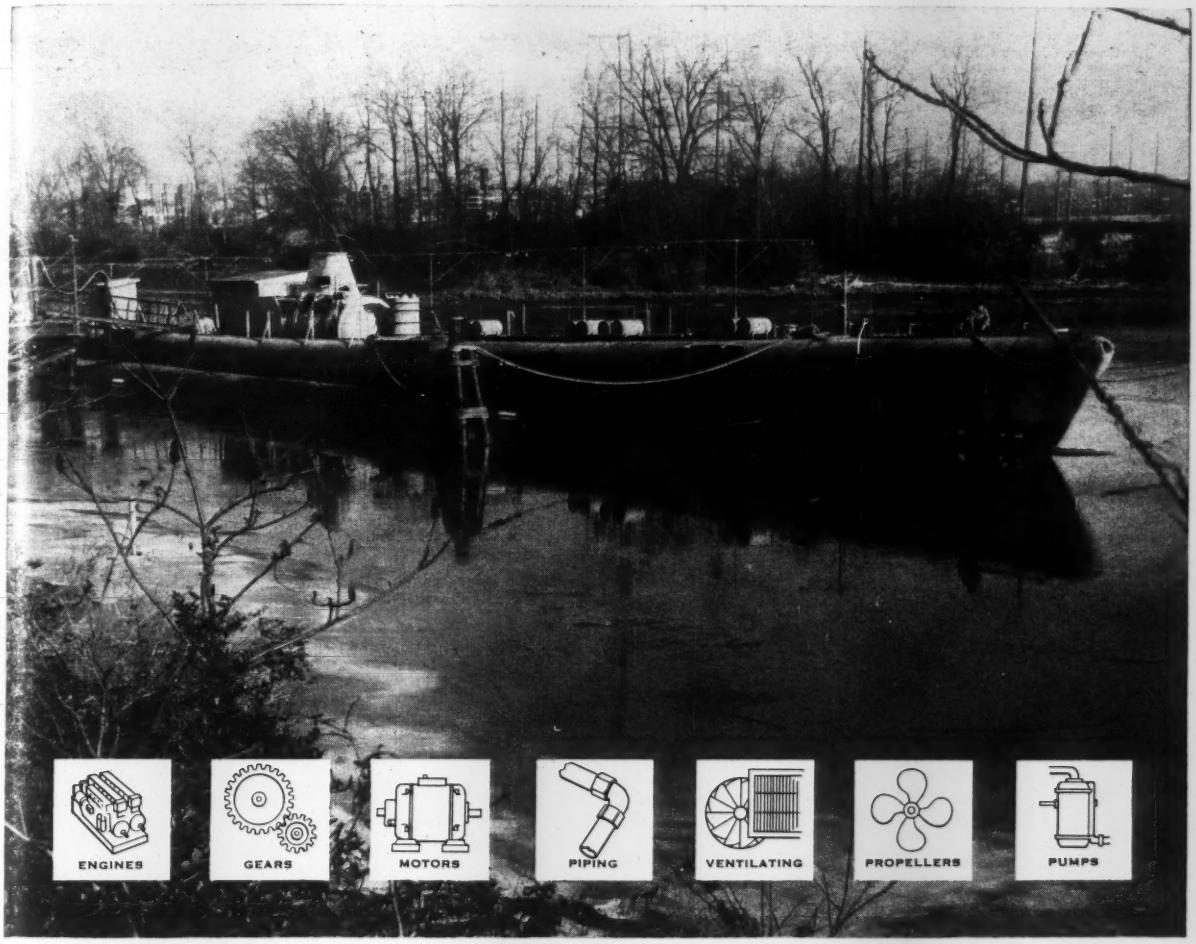
Kulka Electric Mfg. Co. will exhibit new types of molded barrier blocks using new materials.

For more information circle **641** on inquiry card.

Stromberg-Carlson Co., div. of General Dynamics Corp., will present the new XY Data Switching System designed for freight car report sorting.

For more information circle **642** on inquiry card.

BRUSH...*offers complete systems for noise or vibration measurement*

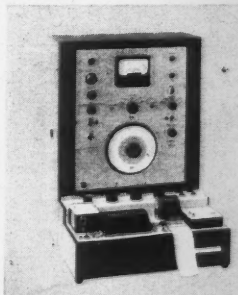


Floating laboratory gets facts on noise to make machinery quieter

In the Navy's experience, a noisy submarine is a dead submarine. Thus, the U. S. Naval Engineering Experimental Station has moored this sub in a quiet spot—and uses it as a test laboratory for noise reduction of machinery and other shipboard equipment.

By recording noise on a Spectrum Recorder, Navy technicians save days of engineering time with automatic analysis and recording of noise amplitude versus frequency. In addition to providing excellent frequency definition, this easy-to-use equipment furnishes a permanent chart record.

For complete information or application assistance on the integrated line of Brush-Bruel & Kjaer instruments for sound and vibration measurement systems call your Brush representative, or write Brush Electronics Company.



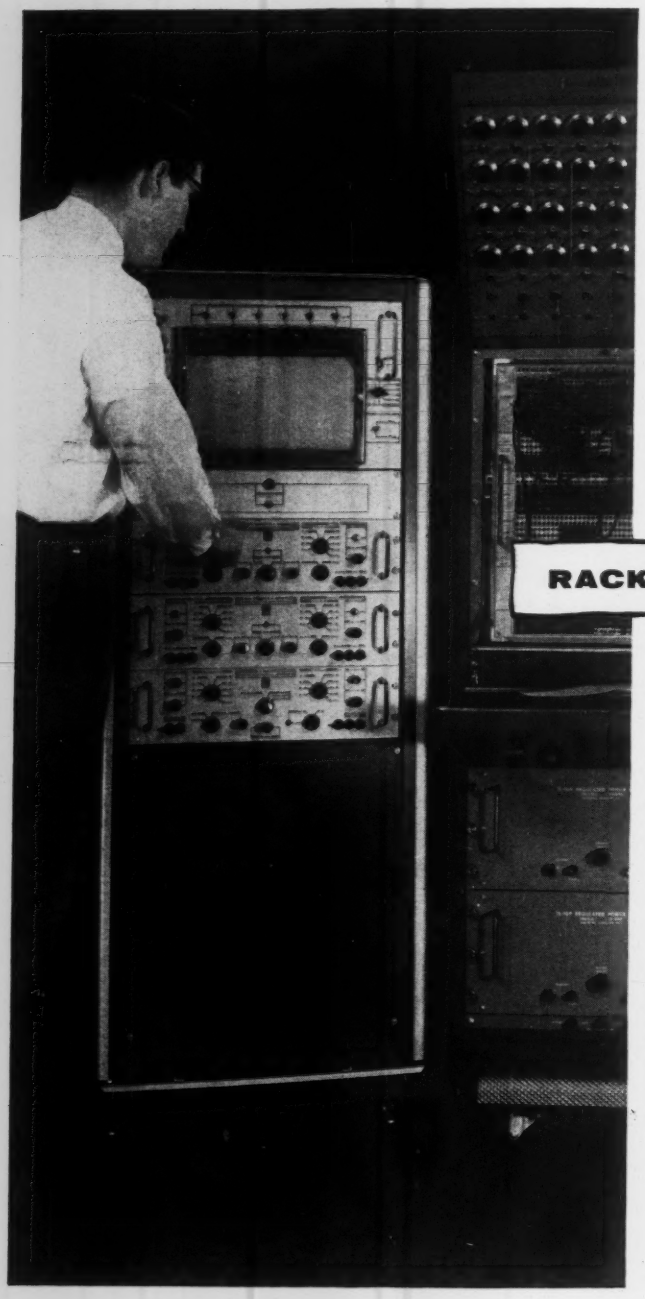
Third-Octave Spectrum Recorder
key instrument in a complete line for noise and vibration measurements.

For information write Dept. A-111.

BRUSH ELECTRONICS COMPANY
3405 Perkins Avenue, Cleveland 14, Ohio
DIVISION OF CLEVITE CORPORATION

For more information circle **49** on inquiry card.

HOW TO SPEED YOUR TESTING

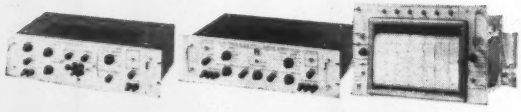


Complete line of

BRUSH RECORDING SYSTEMS

offers exact instrumentation you need to record data faster... more easily

RACK-MOUNTED SYSTEMS



Oscillographs and amplifiers fit standard 19-inch racks. For 1, 2, 4 or 6-channel systems.

MOBILE INSTRUMENT CART

Single or dual-channel oscillograph with accompanying amplifiers may be mounted in this mobile instrument cart. "Instrumentation on wheels" saves engineers' time.

For more information circle **50** on inquiry card.

AND DEVELOPMENT

These direct-writing oscillographic systems record variables from d.c. to 100 cycles per second immediately, eliminate the manual labor in data recording.

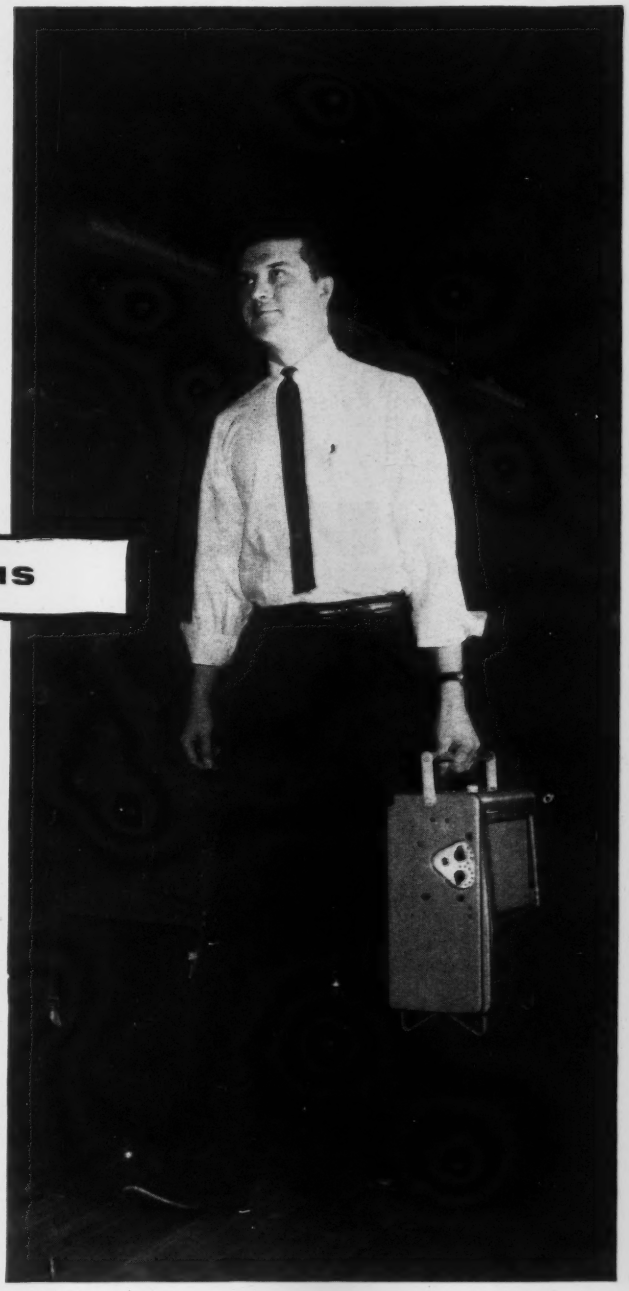
Only Brush offers all these features:

WIDE SPEED SELECTION . . . choice of 8 or 16 chart speeds allows you to select the speed best suited for the variable being measured, assuring optimum readability, accuracy and economy in chart paper.

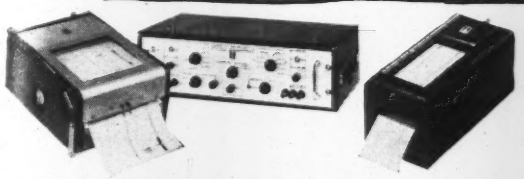
EASILY OPERATED . . . set-up time is at a minimum. Instantaneous switching and remote control streamline operation.

COMPLETE LINE . . . Brush Systems are complete. You have a choice of D.C. Amplifiers, amplifiers for use with either resistive or inductive transducers, or high gain amplifiers. Choice of ink or combination ink and electric writing oscillographs.

GET THE FACTS. . . Ask your Brush Representative for complete specifications, or write Brush Electronics Company, Department A-11, 3405 Perkins Avenue, Cleveland 14, Ohio.



PORTABLE SYSTEMS



Portable oscillographs and amplifiers are light in weight, easy to set up on the job. Four channel oscillograph weighs 38 pounds, 6-channel unit 51 pounds.

IDEAL FOR FIELD USE

Portable units are rugged, designed to stand up under tough field testing conditions, yet perform with laboratory accuracy. Brush equipment is ideal for instrumentation set-up in station wagon, trailer, etc.

BRUSH ELECTRONICS COMPANY

3405 Perkins Avenue, Cleveland 14, Ohio

BRUSH 6 ELECTRONICS

DIVISION OF CLEVITE CORPORATION

For more information circle **50** on inquiry card.

We Asked You

WHAT YOU WANTED TO KNOW

Here's what you said

"We want the Facts about ADVANCEMENT"

"We want the Facts about SALARIES"

"We want the Facts about the NATURE OF THE WORK"

"We want the Facts about LOCATION"

"We want the Facts about BENEFITS"

"We want the Facts about POSITIONS OPEN..."

REPUBLIC MUST FILL 63 POSITIONS IN THESE 21 FIELDS IN THE NEXT 3 MONTHS

1. Aerodynamics 2. Flight Test 3. Dynamics 4. Thermodynamics 5. Electronics 6. Flutter & Vibration 7. Servos 8. Weights 9. Weapons System Analysis 10. Analog & Digital Computers 11. Airframe & Mechanical Design 12. Antennae 13. Fire Control Systems 14. Flight Control Systems 15. Instrumentation 16. Stress Analysis 17. Operations Research 18. Preliminary Design 19. Systems Engineering 20. Propulsion 21. Publication Engineering

Engineers

(in a series of independent surveys)

ABOUT JOB OPPORTUNITIES

Here are Republic Aviation's Answers

..... At REPUBLIC AVIATION expansion has added 43 new supervisory engineering positions in the last 3 years to 156 already existing. 77% were filled by engineers on the staff from 1 to 20 years; 23% from outside the company. 54 additional technical specialist openings created in last 12 months with 26 filled from within.

100% of Republic engineers have received pay increases since January, 1955 and 40% have won increased professional status.

..... At REPUBLIC, top of the industry scale is in force at all levels, but individual contributions bring added financial and professional recognition.

..... Pioneering new concepts in aircraft design and missile science is the business of Republic Aviation. With such planes as the incredible new F-105 Thunderchief (5th in the series of famous Thundercraft) to its credit, the company is now attacking the fantastic problems involved in hypersonic flight. Advanced problems are being studied by the newly organized Scientific Research Staff.

The Missiles Division is engaged in upper atmosphere research and kindred areas (military proposals, contractual projects and company-sponsored programs).

..... We may be prejudiced but at REPUBLIC we think our location — LONG ISLAND — is very hard to beat. This is the famous playground of the East Coast, where modern suburban communities are within easy reach of fabulous beaches... where a man can keep his own boat, play golf, tennis — even polo — yet be less than an hour away from downtown New York with its cultural, educational and entertainment facilities.

..... At REPUBLIC, benefits include our famous 2-PART RETIREMENT INCOME PLAN that's a model for the industry. Also EDUCATIONAL AID, covering 2/3 the cost of advanced study; BROAD INSURANCE COVERAGE — Life, Accident and Health plus Hospital-Surgical Benefits for the whole family.

ALL-EXPENSE PAID RELOCATION PLAN for qualified engineers living outside the New York City-Long Island area

Please send complete resume, including details of technical background, to:

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Mr. D. G. Reid
Engineering Personnel Manager
Farmingdale, L. I., N. Y.

MISSILES
Mr. R. R. Reissig
Administrative Engineer
233 Jericho Tpke., Mineola, L. I., N. Y.

REPUBLIC AVIATION

BRISTOL'S INSTRUMENTATION

News and information about automatic controlling, recording and telemetering

How instrument men pick a winner!

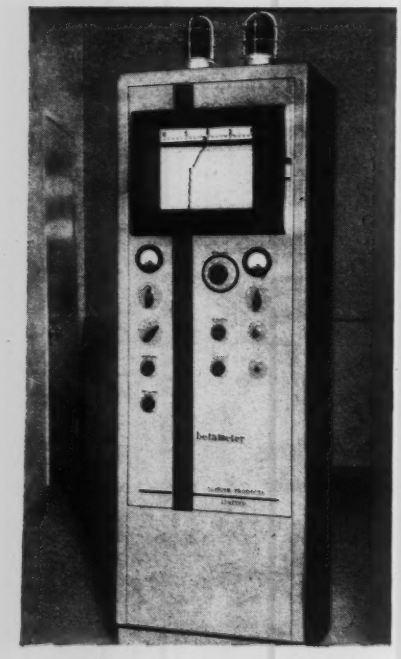
More and more manufacturers are incorporating Bristol's Electronic Dynamaster® potentiometer and precision all-purpose bridge instrument into their own instrument systems. On these pages you'll see a few of its applications—in the measurement, recording and control of any variable that can be translated into an electrical quantity. There are good reasons for this choice of the Dynamaster—whether for plant, laboratory or pilot plant application. Here they are:

1. Continuous standardization eliminates need for dry cells and standardizing mechanism—result: no interruption to control, no dry cells to replace.
2. High accuracy . . . fast operation . . . continuous electronic measurement.
3. Simple in design . . . few moving parts.
4. Easy to use and service . . . little or no maintenance required.
5. Flexible in application.
6. Rugged in construction . . . unaffected by vibration.
7. Plant operating men quickly become familiar with this instrument and like to use it.
8. Versatile for single-pen, two-pen, and multiple record (up to 24 points), with either strip- or round-chart.

ELECTRONIC AND PNEUMATIC CONTROLLERS. Both strip- and round-chart instruments are made in a very wide variety of controllers that meet every control requirement, including:

Electric Control—on-off, proportional input, 3-position, proportioning, proportional with automatic reset, and time-program.

Pneumatic Control—high-gain (on-off), proportional, proportional with reset, and proportional with reset and derivative.



ISOTOPE PRODUCT'S "Betameter."

Gauges sheets to 0.25 lb. in 3000 sq. ft.

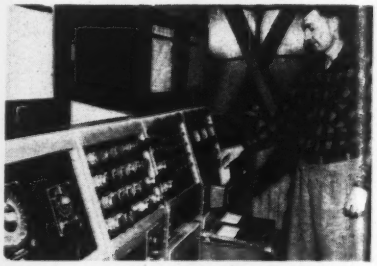
The "Betameter," one of the latest results of modern nuclear instrumentation, was designed and built by Isotope Products of Buffalo, New York, and Oakville, Ontario. It can measure thickness of all continuous sheet materials from tissue paper to 0.070-inch steel. It attains accuracies up to 0.25 pound of material per 3000 square feet.

Beta rays, beamed through the material to be measured, cause electric current flow in a detector. The current, proportional to deviation of the material from the desired thickness, is amplified and recorded, or used for automatic control, by a precision Bristol Dynamaster instrument.

Dynamasters are also used in Isotope Product's "Gammagage" (for measuring heavier materials), "Profiler" (for taking the profile of strip samples), and "Betacoater" (for gauging thickness of coatings).

For more information circle **51** on inquiry card.

Punched-card cement batcher increases accuracy

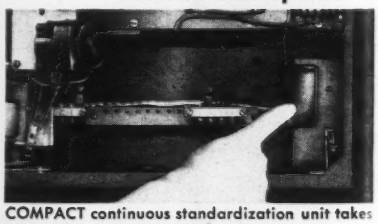


This novel automation system, installed at Cleveland Builders Supply Corporation's Cleveland, Ohio, plant, was designed to turn out twice as much ready-mixed concrete as the company's similar conventional plants.

The operator merely drops a card, punched with the mixing formula, into the machine and the mixture is ready in a matter of seconds. Ingredients are accurate to 2 pounds as against 25 for a human operator. This results in considerable savings in material and also reduces operator fatigue.

Essential part of the installation are the Bristol Dynamaster recorders that provide permanent records of the output of strain gauges used in the weighing process.

How "No-Batt" bans service interruptions



COMPACT continuous standardization unit takes place of dry cell in this Dynamaster recorder.

All the convenience of a line-operated power supply plus the accuracy and stability of a standard cell—that's what Bristol's "No-Batt" continuous standardization gives the user. There are no dry cells to replace and absolutely no interruptions to service for standardization.

This ingenious development achieves voltage accuracy of 1/10th of 1 per cent with an estimated standard cell life of 5 to 7 years.

All Dynamaster models may be equipped with this feature for completely uninterrupted recording, measurement or control—and, of course, the more conventional dry-cell and push-button or automatic standardization are still available.

NEWS AND NOTES

instruments from Bristol . . . leaders in human-engineered instrumentation

Greatest analytical development in decade!

Gas chromatography units, with Bristol recorders, speed analysis

Computing and recording equipment is now aiding automatic qualitative and quantitative analysis of gases and volatile liquids by partition chromatography. Scientists at Gulf Research and Development Co., and Fisher Scientific have built an instrument using a thermostatted chromatographic column to resolve components of each mixture.

As each component emerges from the column, it is detected and a record made on a built-in, accurate high-speed Dynamaster recorder. An automatic integrator simultaneously computes the quantity of component and makes a second record.

Other units which use Dynamaster recorders in this application include Podbielniak's *Chromacon*, Beckman's *Gas Chromatograph*, and Research Equipment Corp.'s *Distillograph*.

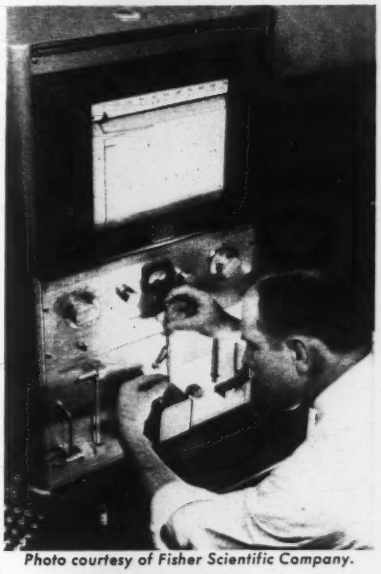


Photo courtesy of Fisher Scientific Company.

Professors turn students at Bristol

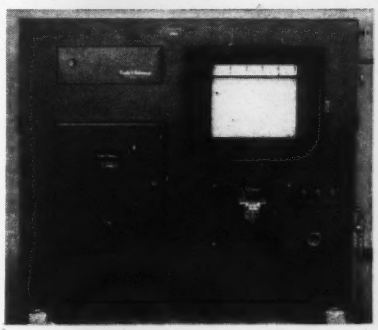
Education for automation started at Bristol back in 1920 with an instrumentation school for our own sales and service engineers. In 1927, we invited our customers' engineers to our school—and in 1949, we opened our first free summer training session (since repeated several times) for professors from engineering schools throughout the country.

Among subjects studied: pressure and vacuum, including liquid level and absolute pressure; telemetering; flow measurements; pyrometers, thermocouples and resistance thermometers; electronic detection; filled thermometer systems and relative humidity; and electrical measurements with voltmeters, ammeters and wattmeters.

Oxygen Analyzer uses Dynamaster recorder

Recording and control of oxygen in gases of all types is the job of this oxygen analyzer, designed and built by Arnold O. Beckman, Inc., South Pasadena, Cal.

The operating principle of the instrument depends only on the paramagnetic properties of oxygen. No combustion, hot wire or consumption of the sample is involved. This precision analyzer uses the meticulously designed and manufactured Bristol Dynamaster recorder to indicate and record its measurements of oxygen content.



Dynamaster component takes to air

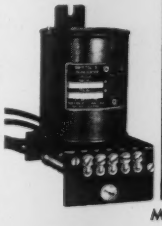
Official U. S. Air Force photo.

Flying high now, as a vital part in military aircraft like that shown above, Bristol's Syncroverter® switch got its start in the Dynamaster potentiometer.

Originally designed to help the Dynamaster endure extremes of shock and vibration (in steel rolling mills and the like), the Syncroverter switch or "chopper" is used now in aircraft to convert d-c signals to corresponding a-c signals, making possible use of highly stable a-c amplifiers.

The Syncroverter switch, noted in aircraft instruments and missile systems for its trouble-free life of thousands of hours, is one of the building blocks that make Bristol's Dynamaster the rugged instrument it is.

SYNCROVERTER switch for instruments.



MINIATURE SYNCROVERTER switch for aircraft.

Technical data available

We'll send you complete technical data on Dynamaster potentiometer and bridge instruments for measurement, recording or control. Or our engineers will be glad to discuss your specific application problems with you. Write today to The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 6.29

WHAT'S NEWS AT BRISTOL . . . WHAT'S NEWS AT BRISTOL . . .

For more information circle **51** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

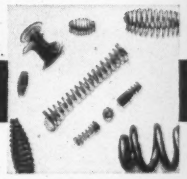
NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

60 second tour

shows it in a nutshell . . .

All-Inclusive Spring Service

COMPRESSION SPRINGS
Regular, Double



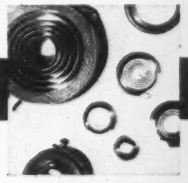
COMPRESSION SPRINGS
Special Shapes
Variable pitch

VOLUTE SPRINGS
Coned end

EXTENSION SPRINGS
Special Hooks
and Loops

EXTENSION SPRINGS
Swivel End
Drawbar

TORSION SPRINGS
Single, double
Edge wound



POWER SPRINGS
Clock or Motor

FLAT SPRINGS
Arched, Curved-beam
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CLIPS, CLAMPS
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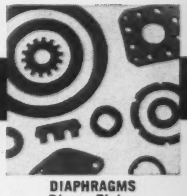
FASTENERS and
RETAINERS

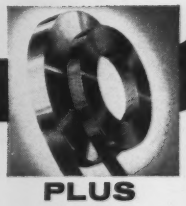
HAIRSPRINGS
for Instruments
Gauges, etc.

SPRING WASHERS
Wavy, Star, Finger,
Expander, etc.

BELLEVILLE SPRINGS
In Series, Parallel
Parallel-series



DIAPHRAGMS
Discs, Plates



PLUS
COLD-ROLLED
SPRING STEEL

Divisions of

ASSOCIATED SPRING CORPORATION

For more information circle **52** on inquiry card.

FOXBORO
TYPE 12 A TEMPERATURE TRANSMITTER
SER.
ADJUSTED RANGE
15 PSI =
3 PSI =
THE FOXBORO COMPANY
FOXBORO, MASS., U.S.A.
FOXBORO
REG. U. S. PAT. OFF.

Rugged, Versatile Temperature Transmitter Improves Remote Control

the Foxboro M/12A (pneumatic)

There is no easier, simpler way to measure remote temperatures, *fast*, over so wide a range, with such high sustained accuracy, and at so low a cost!

Between the limits of —100°F. and +1000°F., with operational spans of 50°, 100°, 200°, and 400°F, this rugged, highly responsive instrument performs outstandingly under the most severe conditions. It is compensated for ambient temperatures and pressure. Derivative action can be furnished for optimum performance when substantial thermal or transmission lags exist.

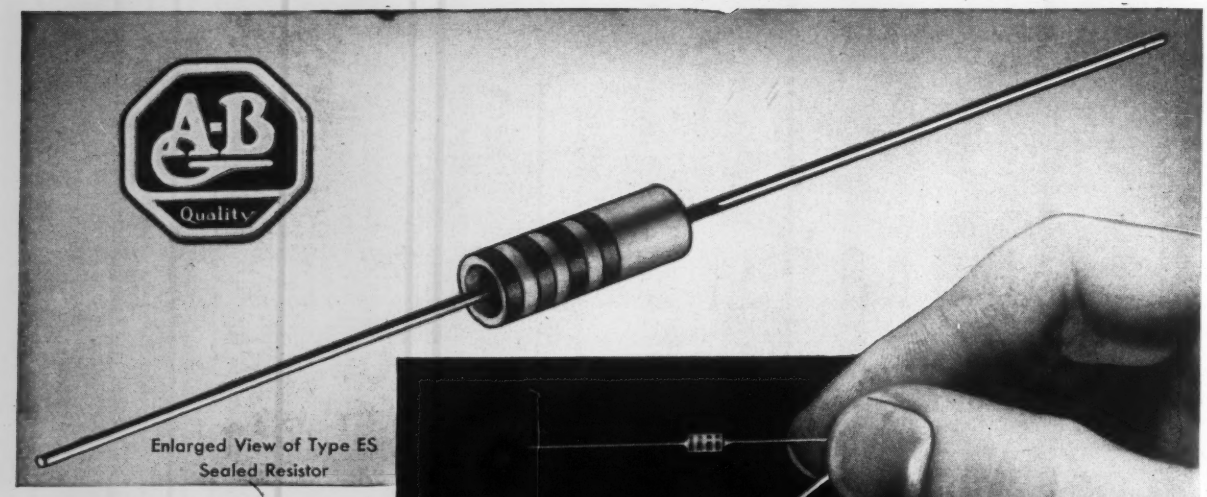
With its weatherproof housing and integral mounting bracket, it can be installed in any hazardous, corrosive, or outdoor location. Transmission lines are standard copper tubing, no electrical hazard, no costly capillary to run.

Write for Bulletin 13-17. It explains fully why the Foxboro M/12A Temperature Transmitter gives better performance with lower installation and maintenance cost. **The Foxboro Company, 4611 Neponset Ave., Foxboro, Mass., U.S.A.**

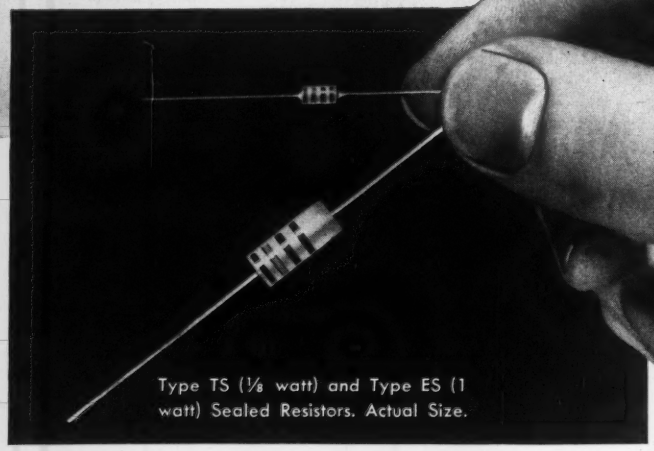
FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

• Pneumatic Temperature Transmission

For more information circle **53** on inquiry card.



Enlarged View of Type ES Sealed Resistor



Type TS (⅛ watt) and Type ES (1 watt) Sealed Resistors. Actual Size.

It cannot be true — But,

Here is what the new A-B hermetically sealed composition resistors will do!

Unaffected by humidity or moisture

Humidity and moisture have been nuisance factors to all composition resistors. The type of hermetic sealing built into the new A-B Type TS and Type ES resistors entirely eliminates this possible objection.

Higher temperature rating

Special techniques have made it practical to increase the operating temperature beyond the rating heretofore considered "safe" with composition resistors.

(Type TS: .125 Watt... 70°C, 0-derating at 110°C)
(Type ES: 1 Watt...70°C, .5 Watt...120°C, 0-derating at 165°C)

2% and 5% tolerances

The amazing stability incorporated in Allen-Bradley composition resistors has made a 2% tolerance a realistic and usable circuit design possibility.

Extremely low noise level

All microphonic noise, occasionally encountered in composition resistors due to shock and vibration, has been eliminated.

From 10 ohms to 500,000 megohms

Although normally supplied in the standard ranges from 10 ohms to 22 megohms, these resistors are also available for special applications in extremely high resistance values, the limits being determined largely by the capability of the measuring equipment.

Catastrophic failure impossible

For the first time a resistor is now available having characteristics approaching wire-wound "precision," plus the established reliability of the A-B hot-molded composition units, assuring complete freedom from catastrophic failure.

Designed for manhandling

The hot-molded Allen-Bradley composition resistor in its ceramic enclosure and high temperature end seals results in an unusually rugged construction, possessing uniformity of size and configuration, making these resistors ideal for mechanical handling.

Allen-Bradley quality and uniformity

Experience gained from the production of hundreds of millions of hot-molded resistors, combined with typical Allen-Bradley quality control, has produced a resistor unique in performance and especially adaptable for the always increasing critical applications of military and computer circuitry. You will want to become better acquainted with this new development in resistors! Representative values can be furnished for test.

A-B

ALLEN-BRADLEY
RADIO & TELEVISION COMPONENTS
QUALITY

Allen Bradley Co.
140 W. Greenfield Ave., Milwaukee 4, Wis.

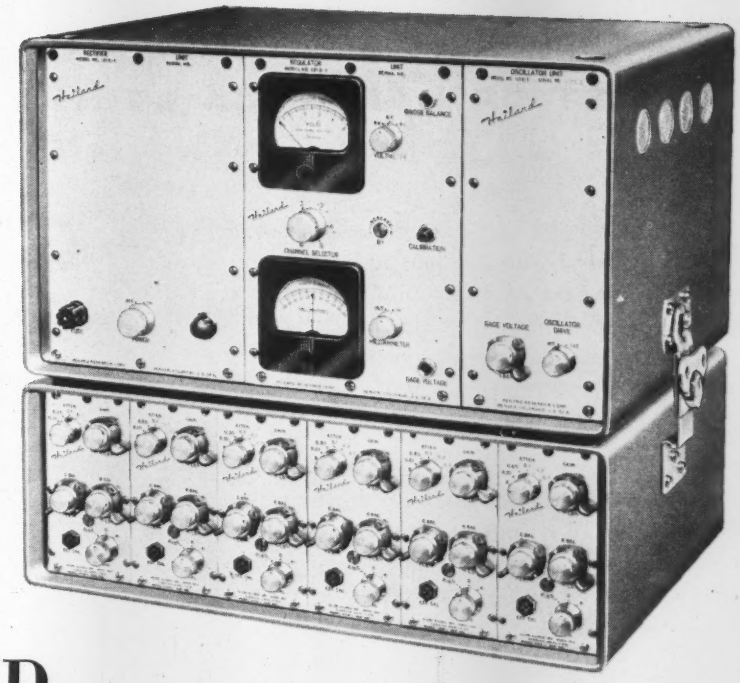
Please send me technical data on the A-B hermetically sealed resistors.

Name_____

Address_____

City_____ State_____

For more information circle **72** on inquiry card.



Carrier Amplifier Units for:
Resistive transducers
Linear differential transformer pickups
Variable reluctance gages

Linear-Integrating Amplifiers for:
Self-generating transducers.

The HEILAND 119 Amplifier System for Oscillographic Recording

All these features—plus many more—have moved Heiland 119 Amplifier Systems into leadership in the field!

All operating controls are on the front panel; all cabling is on the back panel for handy relay rack or test bench mounting without modification.

The 119 System is flexible to meet present or future needs, since all 6 individual amplifier units within the system are easily removable. You can build your system from the ground up, adding new individual units as your need expands.

In addition, linear-integrate and carrier units are interchangeable within the system case.

COMPARE THESE FEATURES with similar systems:

- **TWICE THE SENSITIVITY**
  ½ millivolt for full current output
- **TWO-THIRDS GREATER FREQUENCY RESPONSE**
  0 to 1000 c.p.s.
- **TEN TIMES THE CURRENT OUTPUT**
  50 ma into 20-ohm load
- **EXCELLENT STABILITY**
  less than 2% variation with line voltage fluctuation and wide range of ambient temperatures

FOR ADDITIONAL DETAILS WRITE FOR BULLETIN 101-NA
FOR PERFORMANCE AND CONVENIENCE—CHOOSE THE HEILAND 119 AMPLIFIER SYSTEM.

H HONEYWELL

MINNEAPOLIS **Honeywell**

HEILAND INSTRUMENTS
5200 EAST EVANS AVENUE • DENVER 22, COLORADO

For more information circle **55** on inquiry card.

HOW FAST CAN AMERICA STRIKE BACK?

America's defense is keyed to halt aggression almost as soon as it starts. In seconds, bombers of our Strategic Air Command, guided by a *new bombing and navigational system,* will be able to take to the air, seek out, and smash any threat of war aimed in our direction.

Heart of this new bombing and navigational equipment is an electronic computer, built by IBM. With a speed and accuracy never before possible, this computer sifts through reams of flight and target data, translating them into vital facts for a safe and successful mission.

Careers unlimited

If you are an engineer or a technician, perhaps you would like to work on similar computers for business, government and science—as well as for defense. IBM offers unequalled career opportunities in this virtually "unlimited" field of electronics.

Many IBM benefits

In addition to excellent starting salaries and on-the-job training with pay, IBM offers a chance for rapid promotion through its individual merit recognition system. You'll work in some of the choicest locations in all America and enjoy the advantages of IBM's industry-famous employee-benefit policies.

Write,
outlining your background and interests, to: R. A. Whitehorne, Room 3611, International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.

IBM Laboratories at Endicott, Owego, Poughkeepsie and Kingston, N. Y., and San Jose, Calif.

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IBM®

INTERNATIONAL
BUSINESS MACHINES
CORPORATION

Digital Controllers

DIGITAL AUTOMATION—NO. 13

Digital techniques can be applied directly to servo-type closed-loop control situations. Fluid ratio control is shown to be particularly adaptable to digital techniques. Digital valve-positioning technique permits the control valve to be used directly in the digital automation system.

THE FIELD of digital automation is new and, at present, one does not find many equipments described in the literature. However, as times goes on the digital principles which have been discussed will be adopted into various devices to perform logical operations because of the accuracy, speed, and flexibility of digital techniques.

Several pieces of automatic control equipment already have been designed and are in operation as industrial equipment; an ingenious designer can use these logical elements to perform difficult control tasks. Of course anything that can be done with digital-type logical networks can be done also by other methods. However, the principles discussed are universal in application and the designer's problem is reduced to application of basic principles. If he understands the principles of digital as well as analog techniques, he can select the best for his specific problem.

It is also customary to combine electronic and electromechanical elements in order to arrive at the most efficient design. Electromechanical devices usually can not be used in high-speed control applications. However, when the control is of relatively low speed, electromechanical devices have definite uses. Let us demonstrate three specific applications of the principles discussed. These are:

1. A digital servo to maintain a constant liquid flow ratio irrespective of flow rate.
2. An electromechanical sequence controller.
3. The design of a two-terminal relay network using binary arithmetic.

We will first consider the digital servo-control factors and a fluid ratio-control problem.

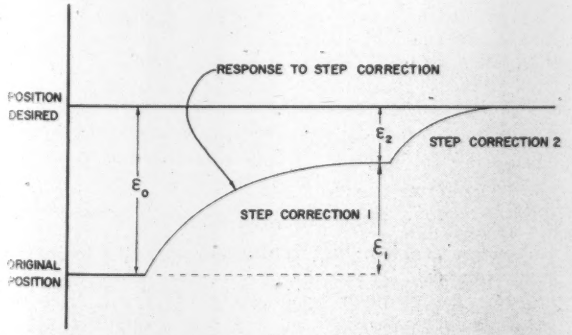


Fig. 13-1. Response of a critically damped servosystem to a step correction made on the basis of a sampled error signal and amplifier gain of 2 or less—that is, the correction is less than twice the difference between the position desired and the original position.

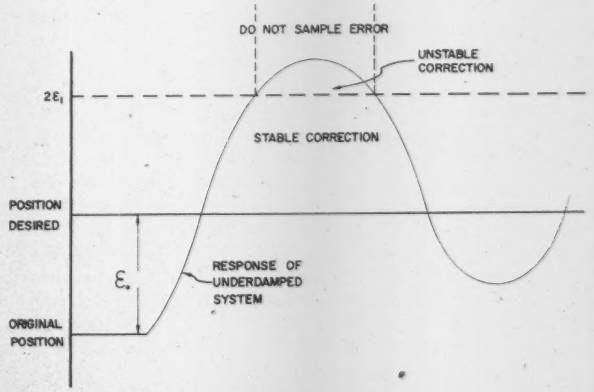


Fig. 13-2. An underdamped system will remain stable if sampling is confined to the safe sampling areas.

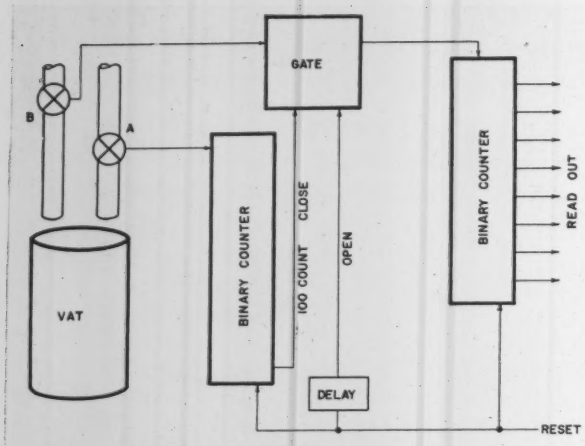


Fig. 13-3. Digital control of the ratio of fluid flows A and B.

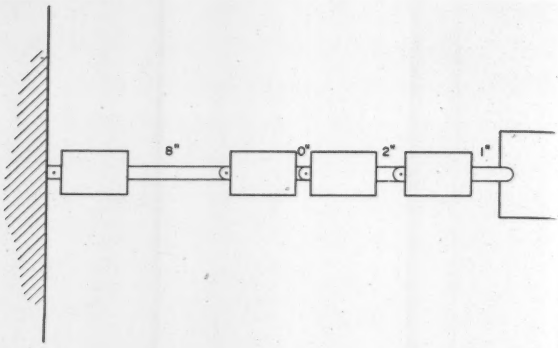


Fig. 13-4. Digital valve positioner comprises four solenoids or cylinders in series. First unit at left moves 8" when energized; next one moves 4" when energized; next moves 2"; fourth moves 1". Hence binary input of 1011 causes stem to move 8 + 2 + 1, or 11 inches, as shown.

Digital Servo Control

Digital servo systems come under the heading of sampled data systems, which are currently at the initial stages of investigation. In a sampled data system, error readings are made at fixed intervals and the error reading is presumed constant during the interval. The servo elements then correct the system in the interval, in direct proportion to the fixed error signal.

As information is lost during the interval when we are *not sampling* the signal, the optimal correction for a sampled data system operating as described is difficult to obtain and requires considerable investigation. However, as was pointed out previously, if the sampling intervals are made more and more rapid, we approach the actual analog signal itself and can, in practice, approach a continuous servo error signal. Hence the usual continuous servo criteria can be used and the digital error signal is merely a convenient medium for on-line computations. Thus the digital sampled error system can be investigated from conventional continuous-error proportional servo criteria. It has been shown that this is true, and that a sampled data system can operate much like a continuous servo system. The advantage of using digital error signals then lies in how much computation must be done on the error signal.

Another servo system is used which depends for stability on very simple criteria. Here a single, noncontinuous correction is made for each error signal. (This is in contrast with the previous example in which the error signal is used during the entire unsampled interval.) The advantage of this system is that a simple criterion for stability exists, as follows:

Let E_0 be the initial error (Fig. 13-1) and k be the controller system gain. Hence at the end of the first sampling interval a correction equal to kE_0 will have been made, and the net error between the position desired and the position attained will be:

$$E_1 = (1-k)E_0 \qquad (1)$$

At the end of the second sampling interval the net error will be:

$$E_2 = (1 - k)E_1 = (1 - k)^2E_0 \qquad (2)$$

Therefore, at the end of n sampling intervals we obtain the expression for error at the end of n sampling intervals:

$$E_n = (1 - k)^nE_0 \qquad (3)$$

Note that if k is any value between 0 and 2, then the expression $(1 - k)^n$ becomes smaller and smaller as n increases. However, if k is any value greater than 2, then the expression becomes larger as n increases. For example, if k is 3 and n is 4, then $(1 - k)^n$ is 2^4 or 16. Thus, whenever k is between 0 and 2 the error becomes smaller and smaller and the system is stable. This is a simple stability criterion; if the over-all system gain is less than 2, the system will be stable in this type of operation.

Now suppose the error signal is used to effect a single proportionate step correction. If the system is critically damped, the system response will be as shown in Fig. 13-1. The system responds to each step input with an over-all gain never in excess of 2.

An underdamped system can be used for faster rise time, provided that the overshoot to the step input is taken into account with respect to the sampling interval. Thus the underdamped system shown in Fig. 13-2 would have to be sampled at times when the response was less than twice the initial error. These safe sampling areas are shown. If the samples are taken in the unsafe intervals (response exceeds twice the initial error) each error would be larger than the preceding one and the corrections would be larger, leading to an unstable servo system.

Fluid Ratio Control

A servo problem that is difficult to solve by analog techniques can be solved readily using all-digital techniques. This problem is shown in Fig. 13-3. Here two fluids are being metered into a common vat. It is desired to maintain a constant ratio of fluid B with respect to Fluid A, irrespective of the flow rate of Fluid A. The ratio is to be maintained by a throttling valve in the Fluid B line. The valve is assumed linear in its operation for this discussion, although nonlinear-valve corrections can be added to the servo.

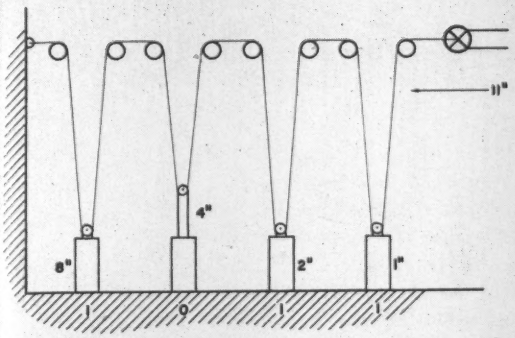


Fig. 13-5. Arrangement of pulleys and solenoids (or cylinders) to cause a linear motion (at upper right) proportional to a binary input.

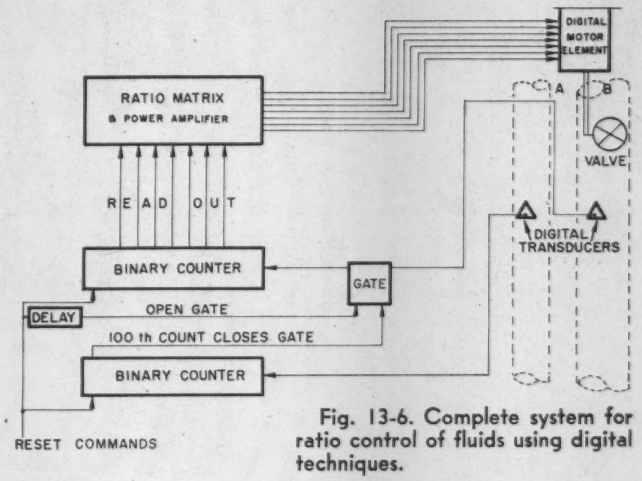


Fig. 13-6. Complete system for ratio control of fluids using digital techniques.

To solve this problem by analog techniques is not simple. The error signal for the system is not obtained directly from the system itself; it must be computed from flow rate information because it is a ratio of two numbers. Another reason for using a digital system is that flow transducers such as turbine or sonic flowmeters are available which produce digital outputs.

The ratio of flows can be determined using digital techniques, simply and independent of the flow rate of the fluid. Let us say that a transducer of the turbine type is placed in each fluid line. Fig. 13-3 shows the pulse output of each transducer being fed to separate counters (flip-flops). We now arrange the Fluid A counter to gate the Fluid B counter. Let us arrange Counter A to close the gate to Counter B on the one-hundredth pulse. The pulses from both transducers start to fill the counters. Finally the hundredth count arrives at the A counter, at a time which depends on the absolute flow rate of Fluid A. At the one-hundredth pulse, no matter how long it takes to arrive, the count to Counter B is cut off. The count standing in Counter B, say 115, is a measure of the ratio because we have to divide 115/100 to get the ratio. Actually it is virtually direct reading and we need only point off two decimal places to obtain 1.15, the flow ratio. The important thing here is that the flow ratio is independent of the flow rate of Fluid A because it always counts to 100 before shutting off the count to Counter B. By arranging a full count of 100 in a short interval of time, this ratio can be obtained as often as desired, simply by using a transducer capable of putting out the required count of 100 in the interval desired. Naturally, as the flow rate of A decreases, the interval for the count increases, but this can be taken into account by using rapid sampling intervals.

The count in Counter B (held in the flip-flops) is then read out directly, obtaining a binary-code representation of the error ratio. If the valve position controlling Fluid B is linear, it is only a matter of making a valve correction in proportion to the error to correct the flow ratio. Suppose we wish the ratio to be 1.00 and the count we obtain is 1.15. We must close valve B in proportion to the error 0.15. This error signal can be used directly in conjunction with a *digital valve* which operates from pulse code.

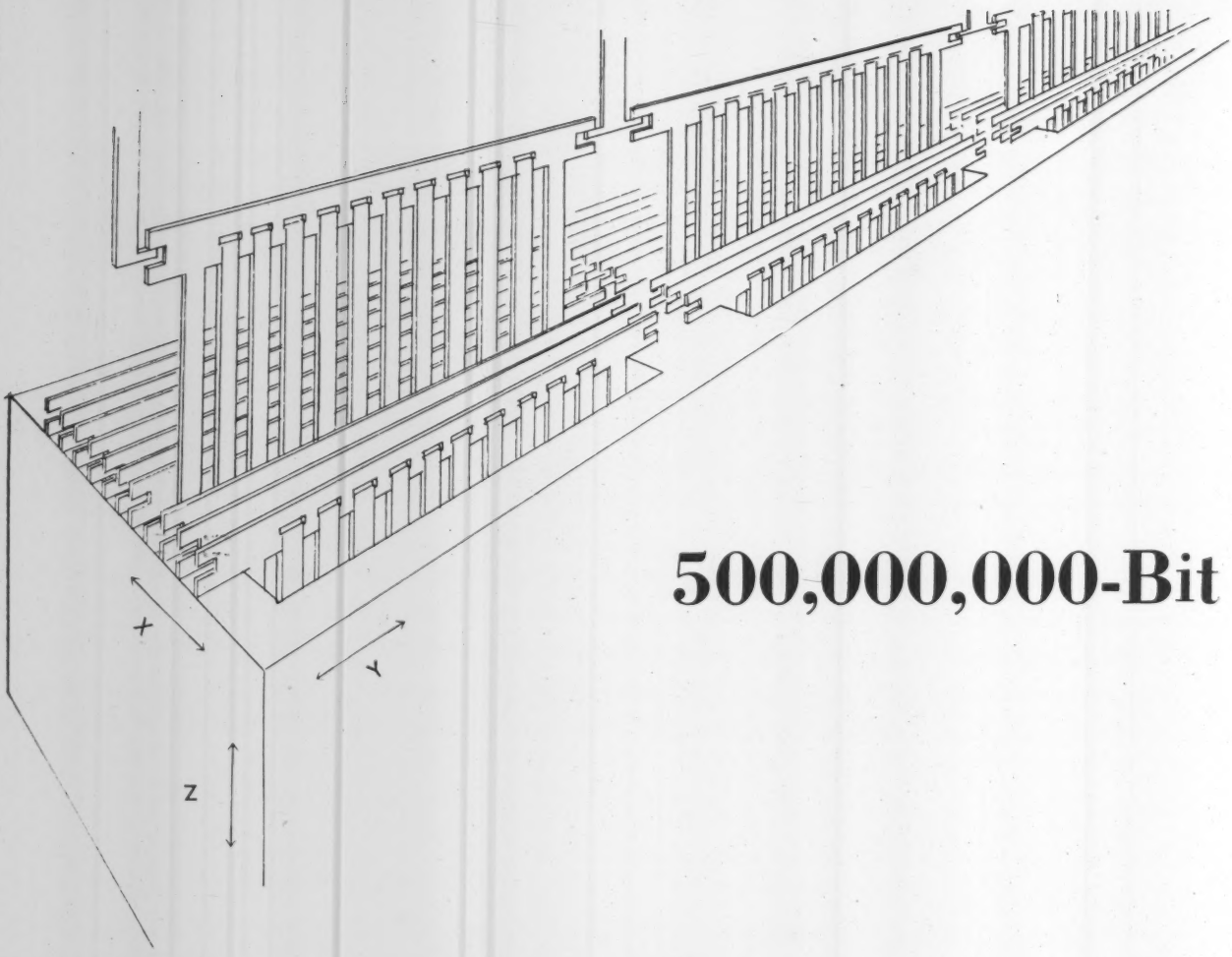
Digital Valve Positioner

Fig. 13-4 shows a simple arrangement for digital positioning of a valve, which can assume any one of sixteen discrete positions. It is essentially a mechanical adding device and has a linear stem-motion output to drive the butterfly valve. Each of the four boxes represents solenoids or cylinders in series. The first one at left can move 8 inches when energized; the next 4 inches; the next 2 inches; the next 1 inch. Hence the output stem can be positioned to any of the 16 discrete values between 0 and 15 inches by energizing the appropriate solenoids.

Suppose the pulse code 1011 arrives at the solenoids, each pulse properly channeled to its corresponding solenoid. The first solenoid will extend 1″, the second solenoid 2″, the third will remain closed and the fourth will extend 8″. As the solenoids are cascaded, the total extended length of the solenoids will be 11″. The solenoids thus directly effect the digital-to-analog conversion for the valve. An arrangement of pulleys and solenoids to do substantially the same thing is shown in Fig. 13-5.

By scaling the solenoid deflection to the valve position and the binary counter, direct digital valve corrections can be applied. Power gating tubes can be used in large valve applications, and a ratchet arrangement between the valve and solenoids also can be used.

Fig. 13-6 shows the entire servo in operation (without reset pulses which precede each sampling interval). A complete cycle of operation consists of sensing, ratio computation, read error into power-controlling devices, make digital correction to valve position. The error is sensed during the interval preceding the correction by accumulating the count in both registers. At the conclusion of the fixed count in counter A, a pulse is emitted which shuts Counter B off from its transducer. This same pulse, after a short delay in a one-shot, reads the count in Counter B and clears it. Counter A has cleared itself since it operates to full count. The count in B is read into the power gates which control the power to each solenoid. The solenoid-valve arrangement, properly damped and scaled, moves the linear valve through the ratchet to its correcting position, then the solenoids return to 0000 position and start the next cycle.



500,000,000-Bit

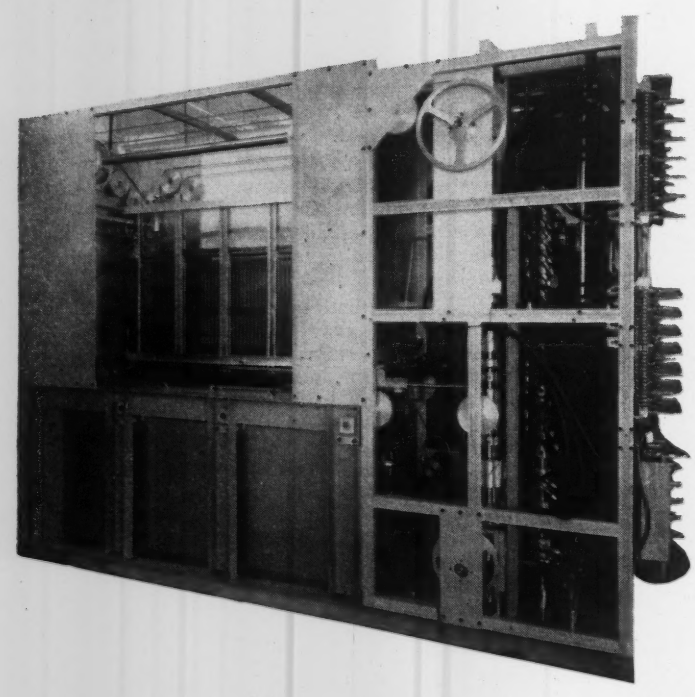


Fig. 1. Front view of RAM with skin removed to show construction features. One page is shown raised into position for reaching the lower-most data location. To extreme right are solenoid-operated valves that direct air pressure to appropriate sides of access cylinders for positioning. The page-selection (x-motion 10-cylinder) system is visible through framework as are the page lifting (z-motion) cylinders. Cylinder motion is transmitted to the access mechanism by means of steel tapes. The storage compartment is pressurized to prevent accumulation of dust on recording surfaces.

GEORGE E. COMSTOCK
Potter Instrument Co., Inc.

All large-scale data-handling problems in warehousing, banking, data reduction, and other fields require storage capacity of millions to hundreds of millions of bits of information. Major impasse today is rapid access to any selected bit from this mass of information. This 500-million-bit storage unit with average access time of about ½ second represents a major technological advance. The digital cylinder-position technique is of special importance.

Random-Access Memory

RAPID strides have been made during the past decade in electronic data-processing equipment and techniques; methods have been developed for performing almost all types of clerical work electronically—with one glaring exception: Only within the very recent past have techniques been perfected for replacing the ubiquitous file cabinet.

The Potter RAM (Random Access Memory) has been designed to replace the file cabinet—and file clerk. It makes possible an automatic clerical system that performs tasks more accurately, faster, and less expensively than is possible by manual means.

The RAM is shown in Fig. 1. It is a machine combining mechanical, pneumatic, hydraulic, magnetic and electrical techniques to provide a large-scale storage system with fast and random access to any desired portion of its tremendous memory. Although design flexibility permits unlimited combinations of operating characteristics, the following combination is typical: The model shown can store more than 500,000,000 binary digits (comprising 64,000,000 8-bit characters contained in 400,000 data locations of 160 characters per location).

The basic storage medium for information in the RAM is standard 5/8" instrument-quality Mylar-base magnetic recording tape. *More than* 40,000 *feet of tape* (nearly 8 miles of recording channel) *are accessible on a random basis within less than a second, with average access time less than ½ second.*

To be presented in a Clinic class at the Third International Automation Exposition, New York, Nov. 27-30, 1956. Class will include the RAM, magnistors, the Magnityper (magnistorized version of the flying typewriter), a new "bin" sorter, and new developments in high-speed digital tape handlers.

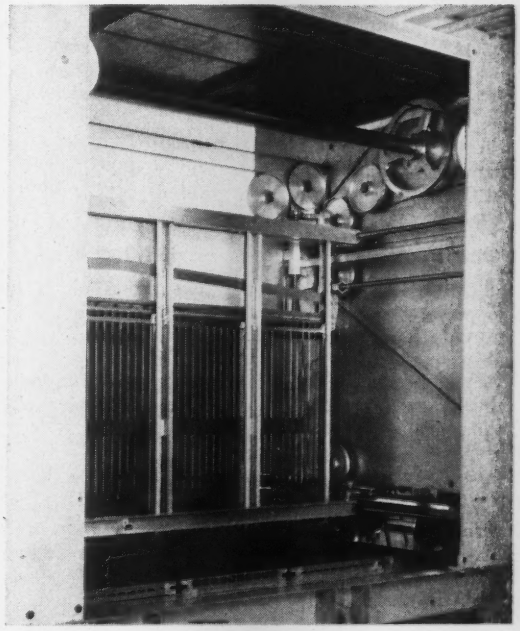


Fig. 2. Three basic positioning motions are used—(1) x-motion for page selection, (2) z-motion for page lift, and (3) y-motion for head positioning. Ten cylinders are required for the x-motion page selection in order to select any 1 of the 200 pages; five cylinders for the 10-position page lift; and four cylinders for the 10-increment head-positioning motion. Thus a 19-bit signal is required.

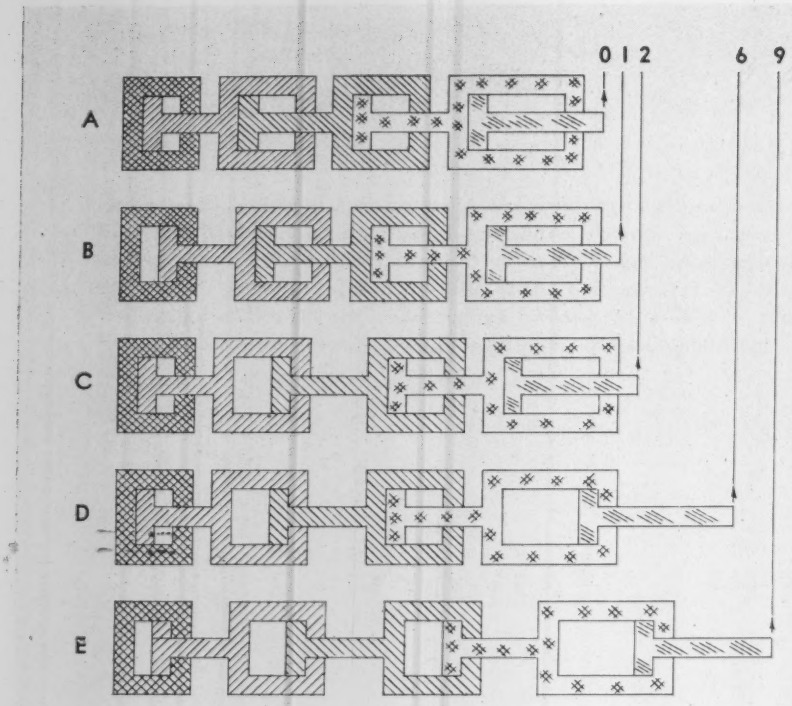


Fig. 3. Principle of the digital-positioning cylinder, showing how four cylinders in series, and with incremental motions of 1, 2, 2, and 4, will permit any of 10 locations to be reached. A, when all cylinders are pushed to left, position 0 is attained; B, when 1-unit cylinder is activated, position 1 is attained; D, when cylinders 2 and 4 are activated, the 6th position is attained; E, when all cylinders are activated, position 9 is attained. Note that any of ten positions are attainable—0 to 9 inclusive.

One Page = Five Paragraphs = 2000 Words

To achieve this extraordinary combination of large capacity and random access, strips of tape approximately two feet long are strung vertically on stainless-steel frames. Each frame is called a *page* and has five *paragraphs*. One page is shown in raised position in Figs. 1 and 2.

Each paragraph has twenty strips of tape (ten strips mounted back to back). As each tape strip accommodates 20 *words* (data locations), each paragraph contains 400 *data locations*.

One Book = 200 Pages = 400,000 Words

Following the book analogy, five paragraphs form a RAM *page*, and 200 pages are used in the RAM *book* to provide a total of 400,000 *data locations*. The 200 RAM pages are housed in a 5-section vertically-slotted bin, each section holding 200 paragraphs. Ten record-playback heads are employed, one on each side of the five paragraphs on each page.

Digital Cylinder Actuators

Access to a selected location is gained by coded sets of serially-connected pneumatic-cylinder actuators. The RAM seeks a given data location in the following manner:

First, the page-selection cylinders are activated, causing the frame to move horizontally over the bin to a position directly over the selected page. This x-motion positioning to 1 of 200 positions requires 9 cylinders (plus a tenth used for retraction and other purposes).

Five pairs of fingers then engage the selected page and lift it upward in an edge-guided framework to one of ten selected vertical positions as defined by the address code. This z-motion positioning requires four cylinders (plus a fifth for zero-position lifting).

Simultaneously with the page-lifting motion, the record-playback heads are moved in tandem to bring one of the ten heads into position for reading the selected data location (this y-motion head positioning requires 4 cylinders). In the slowest case, the portion of the access cycle discussed thus far consumes a little more than ½ second.

Data locations are grouped in pairs, each pair being physically separated on the tape by a ½-inch guard zone. When the page selection, lifting, and head positioning have been completed, the selected record-playback head is activated to record, revise or read information at the selected location.

Coding the Cylinders

As mentioned previously, motion is imparted to the actual access mechanism by means of coded cylinders, as illustrated in Fig. 3. Note that the piston rod of one cylinder is attached to the end cap of the next cylinder so that increments of motion afforded by simultaneous activation of the cylinders are additive.

To define any desired data location, a total of 19 bits of information must be fed to the RAM in the form of on-or-off signals capable of operating 19 of the 38 solenoids that control dual-solenoid valves. These four-way valves operate in push-pull fashion, directing air pressure into appropriate ends of the 19 cylinders to cause the access mechanism to seek the desired location.

Coding of the access cylinder systems is such that the number of possible combinations is exactly equal to the number of possible locations. For example, for page selection, nine cylinders are arranged in series with the following increments of motion: 1, 2, 4, 4, 8, 20, 40, 40 and 80. This permits any one of 199 possible combinations which, together with the zeroth position, provide the required capacity for selecting any one of the 200 pages.

The four page-lifting and four head-positioning cylinders are coded 1, 2, 2, 4 for a total of nine possible combinations which, together with the zeroth position, provide the necessary ten possible positions. This adds up to 9+4+4 or 17 bits. One additional position is provided on the page-selection system for retracting the selection mechanism when the bin is removed, and the 19th position bit is used to lift the selected page for reading the zeroth position.

Read-Write

Once the positioning process has been achieved, ten record-playback heads will have been brought into position for reading as many data locations. The appropriate head-stroking mechanism is then actuated, causing the selected head to go through its read-write motion. This motion consists of moving the head into contact with the tape in the guard zone (separating pairs of locations) and sweeping the head at constant speed over the selected pair of data locations. The first or second data location thus swept may be selected electrically and the other rejected, or the pair may be used as a single 320-character location if 200,000 data locations are sufficient—that is, the equipment offers either 400,000 160-character words or 200,000 320-character words. The heads come into direct contact with the tape, and edge guides insure reliable orientation for recording or playing back of information.

It is necessary to return the previously-used page to the bin before proceeding to another page if the address calls for a page change. This step can be programmed easily and consumes approximately 0.2 second of the access time.

Average Access Time

Average access time to a selected location is less than a half second. Approximately 0.4 second is required for the page-selection motion when the selection frame must traverse all or nearly all of the 200 pages. However, the average access requires motion over fewer pages. Somewhat less time is required for page lifting and head positioning (these motions occurring simultaneously), and approximately 0.15 second is consumed by the head stroke cycle. Typical record and playback clock frequencies are in the region of 2 kc—that is, the pulse frequency recorded is a 2-kc signal.

Although only one head is activated at a time in normal operation, all ten can be activated simultaneously when filling or reading out the entire contents of the RAM storage, making it possible to fill or empty the RAM in approximately two hours.

Bin Flexibility

When greater storage capacity is required, and when the nature of the problem permits stored information to be roughly sorted into general categories, a multiplicity of bins can be processed by a single RAM mechanism. Bins are readily removable and another bin can be placed in position quickly, using a simple hand-operated lift truck. Locating pins guide the new bin into position, eliminating the need for adjustment and reducing the time required to change bins to a few seconds.

Other Features

The basic RAM contains no programming equipment. A terminal board provides external access to all electrical components, including the ten 8-channel record-playback heads, the 38 solenoids for controlling the pneumatic valves, and the two head-stroke initiating solenoids.

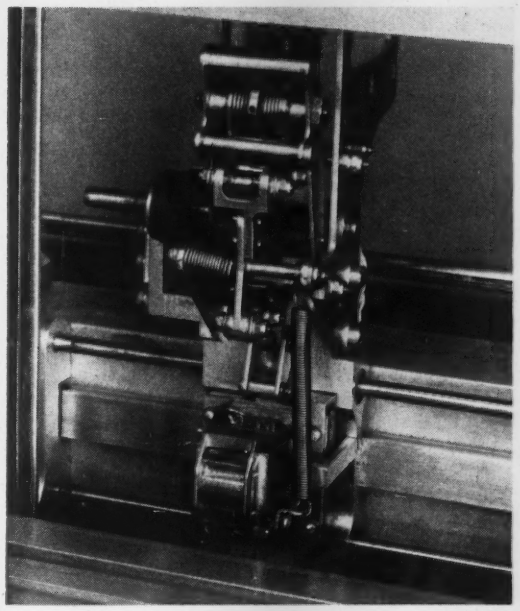


Fig. 4. The head-stroking mechanism. A common rotating shaft transmits mechanical power to all heads. To activate a head, a clutching arrangement is engaged, causing the head to be brought into direct contact with the tape and to be swept down past the data location at constant speed (corresponding to a clock frequency of approximately 2 kc). The 8-channel record-playback head is the polished unit at bottom center.

Also brought out to the terminal board are wires leading to snap-action switches which serve as limit and interlock switches and as position indicators for remote and automatic operation. The latter information is useful in external programming where, for example, it is necessary to prevent movement of the page-selection mechanism while a page is lifted.

Accuracy of positioning and long-term repeatability are, of course, of prime importance in a machine intended for automatic operation. To insure accurate and dependable position, the access cylinders contain large-surface stainless-steel limit blocks, and motion of the pistons is hydraulically programmed in such a way that limit block contact is achieved with negligible impact.

Since the RAM uses conventional magnetic recording tape and record-playback heads, virtually any of the usual input and output devices can be employed—keyboards, magnetic and perforated tape handlers, digital computers, and high-speed printers. Each read-record head has eight channels. Normally, six channels are used for alphanumeric information, one for parity check information, and the other for a clock track.

Typical applications include maintenance of records for insurance companies, mail order houses, government agencies, subscription list fulfillment, inventory control, and so on. The RAM is intended for any application where fast and random access to voluminous quantities of information is required.

Here is the first commercial embodiment of a principle that has long been the subject of great theoretical consideration—optimal control. Control based on the slope of the process reaction is shown to be the direct way to control a process at its optimum. This is a first disclosure—exclusive to readers of *I&A*.

The Quarie

OPTIMAL CONTROL of a closed loop system or servo implies a controller that continuously maintains "best values" of operating parameters. These "best values" frequently require a maximum or a minimum—for example, maximum range, maximum product, minimum fuel usage, minimum product waste, or minimum cost. In short, Optimal Control involves the best compromise of many factors entering the problem. Dollars, as such, generally do not enter as a control parameter, but instead are found everywhere—the cost steam, value of product, cost of labor, etc.

The relationship between the various factors that enter into any control problem is most easily and most often expressed in terms of a curve or a family of curves relating the variables.

For example, consider a process tank (Fig. 1) being heated by steam. The curve of tank fluid temperature vs steam flow generally appears as in B. For every value of steam temperature there is another curve, resulting in a family of curves, as in C. If it is desired to get the tank fluid as hot as possible without wasting steam, the operating point should be the knee of the curve. Control at this point can be specified in terms of the *slope*. This requires a control that will operate at a fixed *slope* of the curve, rather than at any one fixed value of the variable (temperature). Such an optimal controller is thus a slope controller, or a system response controller. It must impose a unit disturbance on the process, analyze the response, and effect a control action to return the process to a point on the process reaction curve of desired slope. This is the principle of the Optimal Controller to be described.

Maxima-Minima

Slope control is an extension of the maxima-minima concept, and maxima and minima are only special cases of zero slope.

Consider the simple example of a continuous reaction taking place in a catalyst bed, the extent of the reaction being a function of temperature. The control setup is shown in Fig. 2. The function of the Optimal Controller is to obtain maximum product independent of variables such as stream mixture, catalyst activity, stream pressure, ambient temperature, and drift in the measurement instruments. Assume that the operating curve of the process has the general form of peaking to a maximum then dropping off with increasing temperature. There will be a large family of such curves, one for each discrete change in each of the variables mentioned above, as shown in Fig. 2B.

If the value of the product is large with respect to the cost of the process steam supplying the heat, then maximum product is required and the Optimal Controller should be set to hold the maxima as indicated by the dots on the peaks of the curves. In the setup of Fig. 2, a temperature controller is shown with its set-point being controlled by the Optimal Controller; in practice the

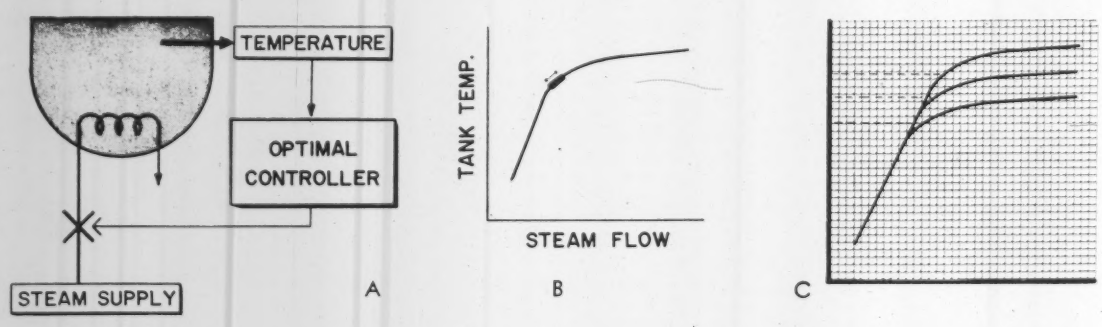


Fig. 1. When steam is used to heat a process tank, the curve of fluid temperature vs steam flow often has the form of a linear rise up to a "knee," followed by reduced steam-heating effect. Optimum control would occur at the knee, as at B. As steam temperature varies, the system characteristics can be described as a family of curves, one for each steam temperature. Control at all times should be at the knee of the curve.

BYRON WHITE
Quarie Controller

OPTIMAL CONTROLLER

Optimal Controller could also set a steam valve directly, with no intermediate controller. The function of the Optimal Controller is to follow the changes in stream mixture, catalyst activity, etc., and vary the temperature in whatever way is necessary to continuously give the maximum possible product for the prevailing conditions.

If the cost of the process steam is a major factor in the eventual value of the product, then the maximum product is probably not the most economical production rate. In Fig. 2C the curves of Fig. 2B are replotted on a steam-flow basis. The dots again show the maxima. A slope on these curves has the dimensions of pounds of product per pound of steam, a ratio for which there is some best number related to the relative values of the product and steam. Thus it may be desirable to control on a slope such as that indicated. The Optimal Controller can maintain control at the proper rate of pounds of product per pound of steam no matter which of the family of curves describes the process at any one time.

Note that this is rate-of-change control—not of a controlled variable with respect to time, but rather of a controlled variable with respect to an uncontrolled variable.

Optimal control can be described as a nonlinear control action, a simplified computer control, a logical control. This is an extension of the problem of maximizing a function A by controlling a function B in which the value of A is in some way known or unknown, predictable or unpredictable, controlled or affected in value by the value of B. To accomplish the requirements of the problem there is absolutely no fixed relation between the input and output signals of the controller, either in magnitude or sense of direction. The purpose is not to hold a parameter at a given value, but rather to allow it a wide latitude of values among which will always be the optimum, which optimum value can itself vary with time because of uncontrollable factors affecting the process.

Defining the Controller Action

To define the controller action, we must first analyze the generalized requirements of the process it will control. The action of the controller must be such as not to upset the process or cause hunting about the desired control point (slope). It must have a damping factor built in so that it will not overshoot, and it must take into account the inherent delay time of the process and the steepness of the control curve. All of these factors are related to "hunting."

The controller imposes a permissible change on the system input, and control action is based on the resultant change in the output. If sufficient allowance is not made for the stabilization time of the process after a change in input, then the "excess" change will hang over into the next cycle and cause hunting. If the control curve is steep, then the input changes must be small so as to limit the

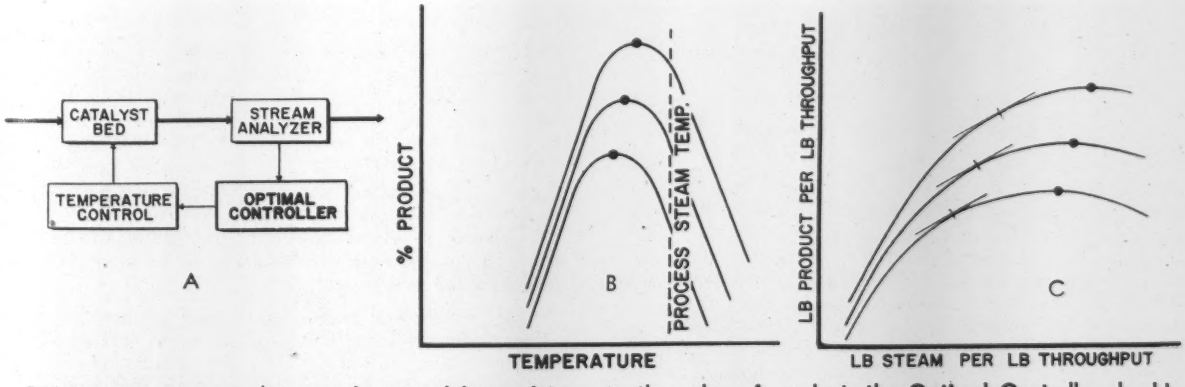


Fig. 2. Many processes have maxima or minima points of zero slope, such as a catalytic reaction whose rate depends on a temperature. Each change in process variable (catalyst activity, ambient temperature, etc.) shifts the operating curve, but a maximum always exists. If the cost of the process steam supplying the heat is small compared to the value of product, the Optimal Controller should cause the reaction to occur at the peaks of the curves, as shown in B. However, if the cost of heating steam is a major factor, the control point can be shifted to the left, as in C.

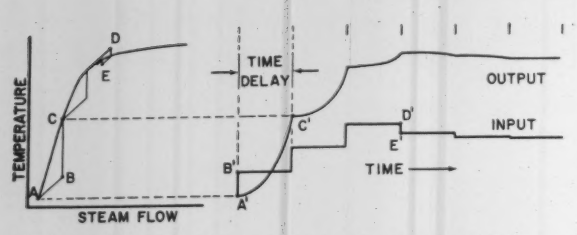


Fig. 3. Control action on a typical process. Left, curve of temperature vs steam flow is operating characteristic. Right, curve of control action vs time.

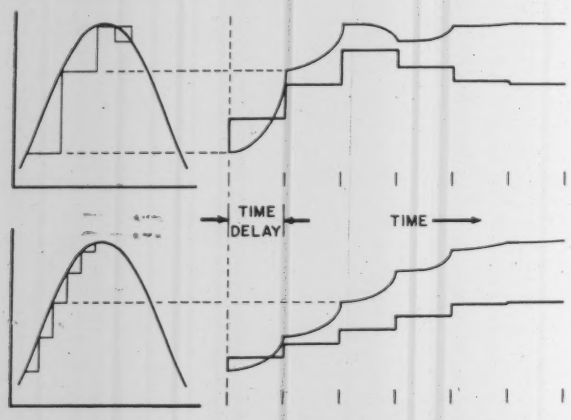


Fig. 4. If initial imposed incremental change is large, overshoot occurs and system converges to control point as shown at top; smaller imposed incremental change causes system to come to the desired control point in the same number of cycles, but without overshoot.

amount of system output change at each step; otherwise, the system will overshoot and search back and forth through the control slope.

The required controller action is as follows: (1) give the input to the system a small incremental change, (2) wait until the system has stabilized, (3) compare the results of the change with the preset instructions, and (4) base further action on the results of this comparison. *Hunting can be prevented by causing the value of the incremental change of system input to decrease to zero as the control point is reached.* This can be termed "proportional-type" slope control, and it eliminates hunting, as follows:

"Proportional" Slope Control

In the theoretical and experimental approaches previously made to this problem of optimal control* the controller imposed a continuous or periodic disturbance on the process. Hence there was continuous "hunting" about the desired control point. The Quarie Optimal Controller eliminates this basic defect by (1) comparing the system response with a desired response and (2) imposing no further change on the system if the desired response is exactly as predicted or desired. In other words, once the desired "slope" is reached, the control action stops and no further incremental change is imposed on the system until the variable being controlled (or any other factor that is known to affect the system) changes in value. The controller then begins its action again. This reduces or eliminates hunting about the desired control point.

The new concept in slope control can be described as "proportional-type" slope control—that is, the corrective signal is *proportional* to the difference between the desired slope and the actual slope, becoming zero when the two slopes are equal. It can be called also "before the fact" control, implying that the controller knows when the system response is correct *before* the control point is reached—as opposed to "after the fact" control in which continuous hunting about the control point always occurs. A "peak-searching" device which knows that a peak is reached only after it has passed the peak must always hunt; in contrast, when the system response is exactly the same as the desired response, the Quarie Optimal Controller imposes no further disturbance on the system until the process variable changes in value. This *proportional-type* or *before-the-fact slope-control* both minimizes the number of imposed changes and eliminates hunting. Control action is immediate after a start-up as there is no need to build up a history of the results of imposed changes.

The Controller in Action

The control action can be understood best by examining its action on a process. Consider the problem of heating a batch process tank from a steam line. Here again there is a family of curves because of such uncontrollable factors as tank deposits, ambient temperature, and other loads on the steam line. One of these curves is shown at the left in Fig. 3. The desired control slope (represented by the line AB) is that slope at which the value of heat in the process tank equals the cost of steam used to supply it. Any excess of steam represents waste; any less means that a more expensive heat source must make it up.

The controller is put "on-stream" at point A. The steam flow is given the maximum allowable incremental change, which is represented by the line A′ B′ and is equal to the difference of abscissas (horizontal distance) of points B and A. Thus, the difference in ordinate (vertical distance) from A to B is the difference between the current value of the temperature A and a new value for the temperature (ordinate B) caused by the arbitrary change in steam flow, *provided that the rate of change of tank temperature with respect to steam flow is in the region required.*

However, this change in steam flow produced a new tank temperature C′ (ordinate C). The time delay from A′ to C′ is the time required for the tank to come to a new temperature. After this delay the current value of the temperature (C) is compared to the predicted value (B) and *found to be higher.* This means the process changed temperature at too rapid rate, which means that the process is below the desired control point. Hence the process is given another incremental change in steam flow in the same direction and of the same amount, the maximum permissible.

Again there is a higher value than predicted; hence another change in steam flow is made, bringing the predicted value to point D. Here the resultant value from the change in steam flow is less than that predicted. Hence the controller *decreases* the steam flow an amount proportional to the difference between the actual and desired values. The system then converges to the required slope control point as indicated by the input and output curves.

As the system converges, the input changes become

* See "Optimalizing System for Process Control," Y. T. Li, MIT, *Instruments & Automation,* Jan., 1952, pages 72-77; Feb., 1952, pages 190-193; March, 1952, pages 324-327.

smaller because they are proportional to the difference between the actual and desired temperatures. When the desired value is the same as the current value there is no output from the controller, and the system stabilizes at the desired control slope. It will stay at that setting until the system changes to another of its family of curves and the controller must relocate the desired control slope.

The value of the maximum incremental change was chosen in the above example in order to illustrate the control action. If a value about half as large is chosen, the system will come to the desired control region in the same number of controller cycles but without hunting or overshoot, as illustrated in Fig. 4.

Elements of the Optimal Controller

The block diagram of Fig. 5 illustrates the elements of the Optimal Controller. The operation sequence is as follows:

1. Compare the current and desired values in the *comparator* and, depending on the instructions to the controller, generate a control signal in the *bistable signal repeater.*

2. Change the predicted-value storage signal to equal the current value as a starting place for a new predicted value. At the same time provide an output and compute and store a predicted differential value as a result of (1) the output change, (2) the desired rate of slope and (3) the slope direction. The output and the predicted differential value may be limited in amount by the *maximum output increment adjustment.*

3. Add the predicted differential value to the current value at the predicted value storage to obtain a new predicted value.

4. If the signal was stored at the signal repeater in the first step, use that signal to reverse the direction sense of future control action.

5. After a period of time equal to the process stabilization time delay, repeat the cycle, starting with step 1.

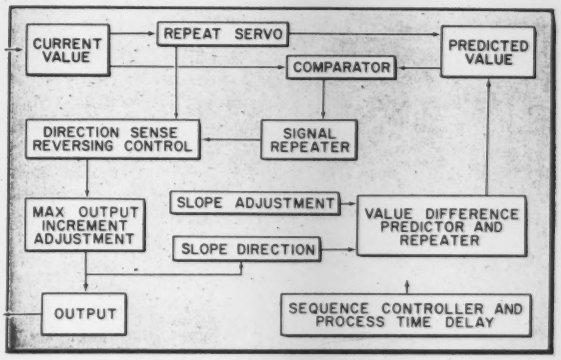


Fig. 5. Elements of the Optimal Controller.

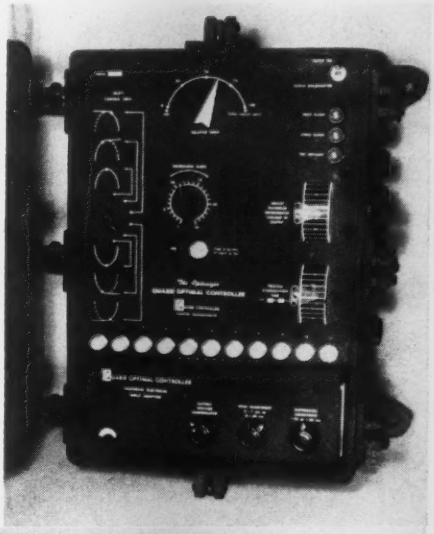
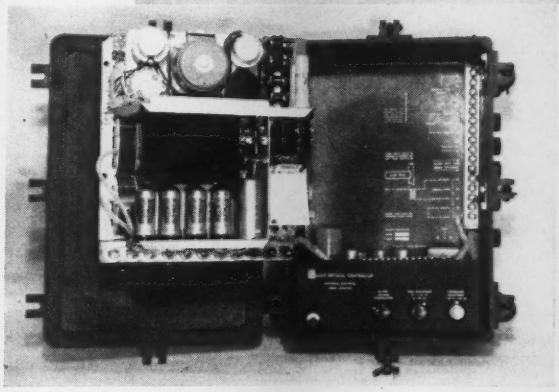


Fig. 6. Commercial model of Quarie Optimal Controller.



Sensing Elements

The controller can receive its input information from practically any type of sensing element, including some sensing elements which are difficult to apply otherwise. For example, the inherently intermittent nature of the Optimal Controller makes it possible to use programmed sampling-type analysis instruments or digital instruments as sensing elements. As the controller is essentially an instrument of differences, and since these differences approach zero as the control point is approached, there is no need for linearity in the sensing elements. Further, the sensing element need only be sufficiently stable to maintain the required accuracy over the process stabilization time; thus the drift caused by deposits on the windows of sampling cells have no effect on the control.

Accuracy

Accuracy does not have the same meaning with optimal control as with conventional linear controllers. In general we are dealing with slopes on broad, slow-changing curves. A ¼% change in slope will allow a large latitude in the instantaneous control point. The repeatable accuracy of the input servo and value-difference predictor determine the accuracy, but by suppressing the zero and expanding the scale to match the range of the current value to the actual range over which the control action will take place, it is possible to obtain a considerable increase in apparent accuracy. Thus it is possible to accomplish good optimal control with comparatively coarse equipment. This allows a number of compromises to be made in favor of reliability in the commercial controller (Fig. 6).

Reliability

A controller which by its nature is intrusted with changing the control parameters of a process must be as reliable and fail-safe as possible. The circuitry of the

subject controllers has been so modified as to make them completely self-checking. This is accomplished by making each step of the operating sequence depend on completion of the last step. This requirement will not be fulfilled if any component fails to operate correctly; if such should happen, an alarm signal is automatically given and the controller disconnects itself from the process, leaving it at the last set-point. At the same time a series of neon lights, which normally show the cycling action of the controller, gives an immediate location of the fault in the circuit.

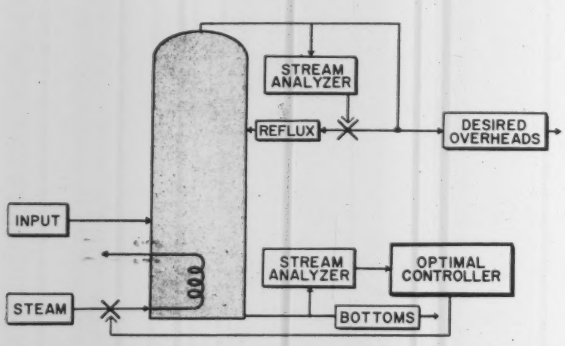


Fig. 7. Typical application is control of overheads quality in a fractionating column.

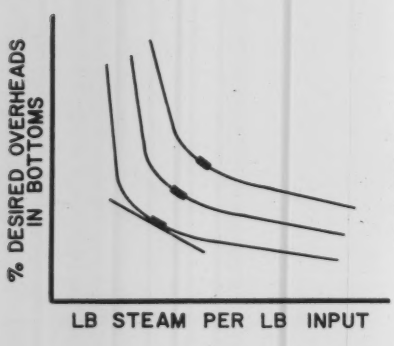


Fig. 8. Characteristics of the process shown in Fig. 7, showing optimal control points.

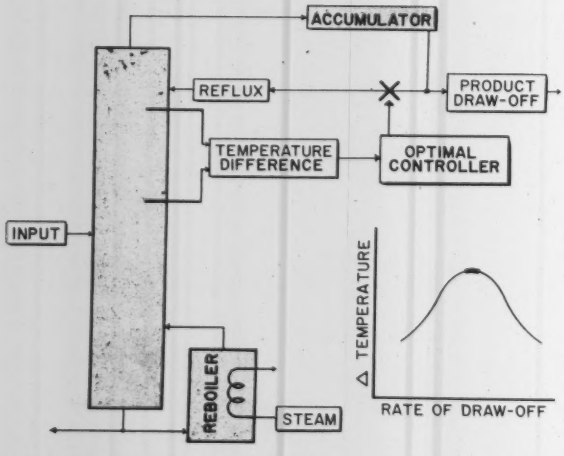


Fig. 9. Direct control of binary distillation column with an Optimal Controller.

Application

It is possible with Optimal Control to maximize the quantity or quality of a product, to minimize a service usage such as fuel, or to optimize an operation or process in terms of dollars. Wherever there is an apparent curve with an area of rapid change in slope there is a possible application of these techniques.

It is not necessary to know the relationship between the variable being optimized and the controlled variable, nor is it necessary that this relationship be either linear or stable. Transient conditions which grossly upset the usual control systems have little effect on Optimizing Control.

In general, the incremental change in process efficiency due to Optimal Control will be small simply because present control techniques are good and the engineering data on which the set-points are based have been well evaluated and the proper compromises made. However, day-to-day variations in "on stream" conditions give rise to deviations from the ideal which cannot possibly be evaluated and taken into account. Conditions often change while data are being taken or evaluated, particularly during apparent upset. The Optimal Controller follows these changing conditions as they occur, and continuously seeks and holds the best compromise in "on stream" conditions. Even though percentage gains may be small, the true worth of the controller is measured by these gains in terms of throughput.

In some types of operations or processes it is apparent where and how optimal control can and should be applied, in others the application is more subtle. In systems with multiple control loops particular attention should be paid to optimizing dollars through a balance of service usage versus product waste.

A typical optimal cost problem is shown in Fig. 7. The overheads in a fractionating column are being held at constant purity by a stream analyzer controlling the reflux line. The bottoms will contain some percentage of the desired product, depending on the amount of steam used, as shown in Fig. 8. A family of curves is required because the mixture in the input lines is not constant. There is some slope, such as indicated, where the cost of the overheads going out the bottoms balances the cost of the steam for taking them out.

Although this may appear to be a rather bad problem to set up without doing much data taking on this system, such control can be accomplished readily by putting the controller "on stream," allowing it to stabilize at three or four settings, bridging the optimal points, and interpolating the setting.

There are also a large number of control applications for which this controller is ideally suited not because it is capable of logical control but rather because it is sensitive to rapid changes in slope. One such application is pH control in which the sensing elements are inherently nonlinear.

Another application of basic type is shown in Fig. 9. The application is the direct control of a simple binary distillation column. A temperature difference is measured by two pickups, several plates apart. The lower one will be sensitive to changes in the input or heat changes in the reboiler. The upper one is sensitive to changes in the product because it is near the output. The control curve is bell shaped; the maximum point will move up and down the tower as unbalances occur. With the Quarie Optimal Controller the maximum point can be stabilized at a known point. This is not practical with linear controllers because the absolute magnitude varies with the pressure in the column.

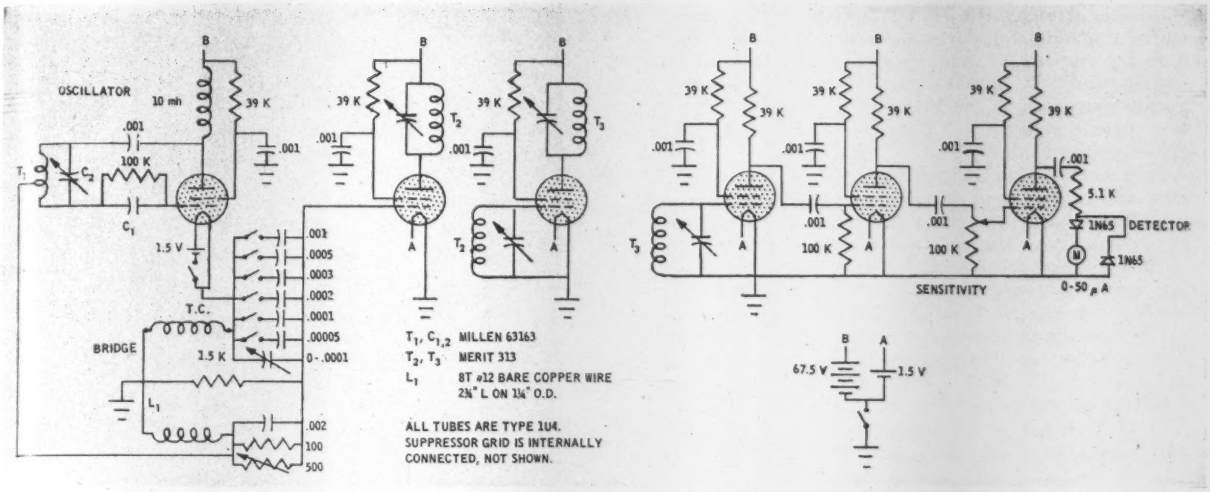


Fig. 1. Circuit diagram of thermocouple tester. The thermocouple is one leg of the inductance bridge, which is energized by the 1.5-Mc oscillator. Bridge output (across the 1.5K resistor) is fed to the 5-stage amplifier.

Inductance-type
THERMOCOUPLE TESTER

Development of a portable battery-operated instrument capable of detecting a short-circuit four or more inches from the hot junction of a five-foot-long thermocouple is described. A signal having a wavelength much greater than the electrical length of the thermocouple is used to measure thermocouple inductance.

PETER R. MORRIS
National Lead Company of Ohio

ONE SOURCE OF ERROR in temperature measurement by thermocouple arises when the thermocouple is short-circuited elsewhere than at the desired point of measurement. A short circuit can occur when a thermocouple is subjected to physical abuse, or when metal is either spilled or condensed on the couple. If the short circuit is near the measuring point, it is difficult to detect and results in temperature readings which may be low by hundreds of degrees.

A method was desired for detecting a shorted condition in a chromel-alumel thermocouple with 0.066″-diameter wires, and with a center-to-center wire spacing of 9/64″. Its length is about five feet. Its d-c resistance is about 0.75 ohm.

A search of *Chemical Abstracts* (Volumes 1 to 47) and *Engineering Index* (1951 to 1954) revealed only one reference[1] of interest. The instrument described by Sherman relies upon a current pulse to fuse high-resistance faults. Faulty operation is detected when the thermocouple reading changes after operation of the instrument.

Choice of Method

As resistance varies with temperature, heat treatment, and contamination, the use of resistance measurements as an indication of thermocouple condition was ruled out. Measurement of *thermocouple inductance* and the measurement of *resonant frequency* are not appreciably affected by the conditions listed above. Of these two measurements, inductance measurement was chosen, as its instrumentation was thought to be the simpler.

Description of Instrument

The present instrument (Fig. 1) consists of a 1.5-Mc radio-frequency oscillator, a bridge, five stages of amplification, and a detector. A Hartley shunt-feed circuit was chosen for the oscillator. The bridge is placed in the a-c cathode return between cathode and the coil tap on T_1. This permits grounding one end of the thermocouple.

This article is based on work performed under Contract No. AT(30-1)-1156 between the Atomic Energy Commission and National Lead Company of Ohio.

With this arrangement, if the thermocouple is open-circuited the oscillator does not function and the detector does not respond to bridge setting, indicating the open-circuit condition. Molded-silvered-mica 5% -tolerance capacitors are used in the bridge. Unbalanced bridge voltage appears across the 1.5 K resistor and is the output signal of the bridge.

Five stages of amplification follow the bridge. The first and second, and the second and third, are tuned-transformer coupled. (It is necessary to detune one of the transformers slightly to avoid sustained oscillations in this part of the circuit.) The remaining two stages are resistance-capacitance coupled. A potentiometer is used in the last stage as a sensitivity control. The output of the final stage is used to drive a 0-50-uamp microammeter. Values in this portion of the circuit may seem questionable (5.1 K shunting the plate load to ground) but have proved satisfactory in practice.

A photograph of the instrument removed from its case is shown in Fig. 2.

Testing Procedure

The sensitivity of the instrument is inversely proportional to the length of the thermocouple. It is therefore important that measurements be made as close to the hot junction as possible. The present instrument has been able to detect a change in length of two inches in five feet, in laboratory tests on a cold couple.

The system geometry is extremely critical. A rigid jig should be used to fasten the instrument terminals to the thermocouple header terminals. Once this junction is made, the sensitivity is turned down, all bridge switches are placed in the open position, and the instrument is turned on. The sensitivity is turned up to provide full-scale deflection on the microammeter. The switches are closed, starting with the largest capacitor, and the meter deflection is noted. If the meter shows a marked decrease, the next capacitor is switched in. This process is repeated, increasing the sensitivity as required, until the meter shows either no marked change, or an increase. When this occurs, the last capacitor is switched out, and the next smallest is tried. The 500-ohm potentiometer shunted by the 100-ohm fixed resistor provides compensation for the resistive component of the thermocouple and should be adjusted to give a minimum meter deflection. When the null has been located, the bridge setting is noted. Serious departures from this setting during later measurements on this same couple indicate a change in couple geometry.

Performance of Instrument

Variations in measurements obtained during plant tests over the temperature range of the couple have limited instrument accuracy to the detection of a four-inch short in five feet. In twenty days of plant testing, the instrument detected two defective couples. Both defects were of a gross nature; in one case, the couple was shorted six inches from the header. In the other, a metal stringer was observed hanging from the hot junction. Correlation of bridge reading with temperature is sufficiently poor that temperature corrections of bridge readings can be omitted with little sacrifice in accuracy of results.

Recommendations

Possible modifications include the use of ganged tuning capacitors to eliminate switching, and the use of an internal heterodyning oscillator and intermediate-frequency amplification to simplify the amplification problem.

Fig. 2. Thermocouple tester has chassis dimensions of 5" x 9" x 3". The oscillator and its tank circuit are at the right side of the chassis. The "dummy" coil which forms one of the two inductive legs of the bridge is to the left of the oscillator. The thermocouple connection posts are at the lower portion of the chassis front. The six switches, symmetrically arranged in two rows, engage the capacitors of the bridge. The jig used to fasten the instrument to the thermocouples in plant tests is shown to the left of the instrument.

Selection of Measuring Frequency

A frequency of measurement was desired for which the inductive reactance of the thermocouple was appreciably greater than the resistance and the shunt capacitive reactance.

The equations[2] for distributed capacitance (C_1) and inductance (L') of parallel cylindrical conductors in free space are given in equations 1 and 2, as follows:

$$C_1 = \pi k_0 / [\cosh^{-1} (c/2a)] \qquad 1$$

where k_0 is the permittivity of free space, c the center-to-center wire spacing, and 2a the wire diameter. (The substitution of c for d as used by Harnwell was made in Eq. 2 for consistency.)

$$L' = [\mu_0/\pi][\log_e (c/a)] \qquad 2$$

where μ_0 is the permeability of free space. These expressions do not include the decrease in inductance associated with the skin effect. The values of distributed capacitance and inductance for the thermocouple described above were found by Eqs. 1 and 2 to be 6.10 micromicrofarads/foot and 0.18 microhenry/foot.

The equation for *input impedance* (Z_{sc}) of a line terminated in a short circuit is given by Everitt[3]

$$Z_{sc} = Z_0 \tanh (\gamma l) \qquad 3$$

where Z_0 is the characteristic impedance, γ the propagation constant, and l the length of the line. The values of Z_0 and γ may be obtained from

$$Z_0 = (Z/Y)^{1/2} \qquad 4$$

and

$$\gamma = (ZY)^{1/2} \qquad 5$$

where Z is the impedance per unit length along the line, and Y is the admittance per unit length across the line. Z and Y are given by $R_1 + j\,\omega\,L'$ and $j\,\omega\,C_1$, respectively.

where $\omega = 2\pi f$ and R_1 is the resistance per unit length.

Using values obtained from Eqs. 1 and 2, we have for a frequency (f) of 10^4 cycles per second

$$Z = 0.15 + j0.0113 \text{ ohm/ft} \quad 6$$

$$Y = j0.389 \text{ micromho/ft} \quad 7$$

Substitution in Eqs. 4 and 5 of the values given in Eqs. 6 and 7 and use of these results in the solution of Eq. 3 gives

$$Z_{sc} = 0.750 + j0.055 \text{ ohm} \quad 8$$

This is the same result we should have obtained simply by multiplying Z by five feet, the length of the couple. In effect, we may treat the distributed resistance and inductance of the couple as lumped elements. Such treatment gives three-figure accuracy (with the thermocouple in question) to 1.5×10^6 cycles per second.

While the approximation

$$Z_{sc} = Zl \quad 9$$

is valid to 1.5×10^6 cycles per second, changes in R_1 and L' associated with the skin effect require a knowledge of the permeability and conductivity at every point along the thermocouple for the computation of these quantities. Since these quantities can not be determined accurately, Eq. 9 can be used only as a rough guide in the choice of measuring frequency.

It is apparent from Eq. 8 that a frequency of 10^4 cycles per second is too low because at this frequency the resistive component is much greater than the inductive reactance, and a bridge employing this frequency would be extremely sensitive to resistance variations. The maximum frequency which can be used is governed by the value of the shunt capacitance. The couple should resonate near 50 megacycles. A frequency of 1.5 megacycles was chosen as the measuring frequency because of the availability of oscillator coils and tuned-transformers for this frequency.

Attempts to use the thermocouple as the inductive element in a tank circuit to control oscillator frequency were unsuccessful because of the low Q. Circuitry and tube selection were somewhat limited by the desire to keep the equipment portable and battery-operated.

Adaptability to Other Thermocouple Types

The present instrument is suitable for testing chromel-alumel couples of the type described whose length is greater than four feet. By interchange of variable capacitors and fixed capacitor positions in the bridge, couples of lengths up to four feet of this type—or of other types having a lower distributed inductance per unit length, or shorter length—could be tested.

In general, the choice of test frequency is governed by the ratio of inductance per unit length to resistance per unit length. The higher this ratio, the lower the test frequency which may be used without the instrument being unduly sensitive to resistance changes. The test frequency should be chosen as low as is commensurable with the above requirement, to avoid complications arising from a change in inductance associated with the skin effect. This effect is a function of resistivity and permeability, and as such is temperature dependent.

A typical platinum vs platinum-13%-rhodium thermocouple has 0.020″-diameter wire, a center-to-center wire spacing of approximately 3/32″ and a length of 2 ft. Such a couple has a calculated distributed inductance of 0.27 microhenry/ft, and a measured resistance of 0.9 ohm. If the frequency involved is low enough to permit lumped treatment, the total inductance of such a couple would be 0.54 microhenry. This should be compared with 0.90 microhenry and 0.75 ohm for the couple described in this article. Since the ratios of L'/R are of the same order of magnitude, it may be assumed that 1.5 Mc would be a suitable measuring frequency for this couple also. This couple would, however, require interchange of variable and fixed capacitor positions in the bridge.

Other designers may prefer to modify the bridge to permit continuous tuning. A four-inductance slug-tuned bridge offers advantages in this respect.

The absolute linear sensitivity (distance from the hot junction at which a short may be reliably detected) is inversely proportional to thermocouple length.

There are secondary effects resulting in changes of inductance which are temperature dependent. Two of these effects are thermal expansion of the insulators and wires (affecting separation and ratio of separation to wire diameter) and changes in inductance associated with skin effect. Efforts to correlate bridge measurements with hot junction temperatures over the range 0 to 2000°F indicate a negligible increase in precision would be gained by application of a temperature correction.

Acknowledgments

The writer is indebted to J. P. Scheuer and J. Kramer of National Lead Company of Ohio for their many helpful suggestions regarding the instrument.

1. Alex Sherman, *Instruments and Automation*, Vol. 27, No. 1, Jan., 1954, pages 124-125.

2. G. P. Harnwell, *Principles of Electricity and Electro-Magnetism*, McGraw-Hill, New York, 1949, pages 42, 328.

3. W. L. Everitt, *Communication Engineering*, McGraw-Hill, New York, 1937, pages 111, 112, 158.

Done Right

"We're taking time to do things right,"
The leader said to his men.
"This once there'll be no oversight,
Or it will wreck again!"
And so they built an engine from scratch,
With all of their elegant tools.
Their methods had no other match,
And they overruled the rules!
The drawing showed the tolerance
Between the bearing seal
That months ago they tried it once,
But now they'd go by feel.

So on that sturdy stand they built
A cylinder with bolts,
And instruments up to the hilt
That measured even volts.
The green and yellow pedestal
Withstood the tests of grime;
No matter what was placed there,
It balanced every time!
And what was said to be the worst
Of all the engine plans
Seemed here to fit so easily,
Like stacks of pots and pans!

—Clifford B. Haughton, Jr.

Valve Sizing

Basic factors in valve sizing include (1) maximum and minimum flows to be controlled, (2) maximum and minimum pressure-differentials across valve, (3) specific gravity, (4) temperature, (5) viscosity, (6) flashing, and (7) rangeability. Here are the basic procedures, with emphasis on the orders of magnitude of the various considerations.

C. S. BEARD

Foster Engineering Company

WHEN sizing a valve the engineer or designer must depend on the valve manufacturers for flow data on available valves. Most valve manufacturers have gone to great lengths to provide test-proved data on the capacity of their valves. However, discrepancies in calculations of the size of a valve are not nearly as common or serious as incorrect analysis of operating conditions, such as the following:

Maximum Flow Rate

The first fact needed is the maximum flow rate. The flow sheet of the process plant or refinery is the starting point for this information. Flow of fuels, heating, or cooling mediums must be determined by analysis of the equipment.

Always start by noting the highest flow rate listed and *justify its existence;* watch for a flow rate that has been increased successively by several engineers just to be on the safe side—even though most plants of today exceed the design before they have been on the line very long.

Pump capacities give a good clue to flows. It is unreasonable to size a valve for more than the pump in the system can deliver. When flow rates listed on the flow sheet are consistently much lower than the pump capacities, either the pumps are being sized incorrectly or someone expects to increase the capacity of the plant over the listed flows.

Ultimate Maximum

Determination of flow rates in distribution systems or in transmission lines requires analysis of the *expansion rate* and *ultimate maximum* of the system. In most cases, a predetermined ultimate for each step in expansion will allow a maximum flow rate to be selected.

Minimum Rates

Establishing a minimum flow is, in most cases, more difficult than determining the maximum. In many installations the minimum flow rate is zero. This is not a difficult condition in itself because many valves are designed for positive lockup at maximum pressure-differential. Difficulty appears when the valve is called upon to control flow rates accurately from zero to a large maximum.

Most applications of this type are sized for the maximum flow using a positive-lockup valve, and somewhat less accurate control at lower flow is tolerated. The low flows in such systems may be handled by a small valve which becomes active at a setting that occurs after the large valve is throttled down.

Differential Pressure

Analysis of a system to determine the pressure drop available across the control valve requires a common-sense approach. It is *not* common sense to say arbitrarily that the size will be determined by a pressure drop of 10 or 20 psi or any one given value. The pressure drop which will exist across a valve is the difference between the source pressure *minus* line and fitting losses on the upstream side of the valve, and the pressure required at the equipment being served *plus* the line loss between the control valve and that equipment.

Determination of the differential pressure is not difficult when a large constant-pressure header furnishes gas to a regulator holding a constant downstream pressure. Nor is it difficult when controlling a constant level in a pressure tank delivering flow to a constant-pressure fractionating column. Trouble occurs when long lines and variable pump-discharge rates vary the upstream pressure to the valve as the flow changes.

Look at the system carefully if the pressure drop available across the valve is (1) less than 10% of the upstream pressure, (2) less than one third of the total drop of the system, including the valve, or (3) less than 4 psi in low-pressure liquid systems.

After establishing the maximum flow rate, minimum flow rate, and maximum and minimum differentials across the valve, the first consideration is to choose a valve of sufficient size to handle the maximum flow that will occur. Under the ideal condition of little variation in differential pressure, the size is determined using this differential pressure. Under variable differential-pressure conditions the minimum value of differential pressure (the value at maximum flow) will be used. Analysis of this size as compared to the size required to pass minimum flow at maximum differential will determine whether the valve has rangeability to handle both conditions. (A discussion of rangeability follows this discussion of the sizing method.)

Excessively high pressure-drops require consideration

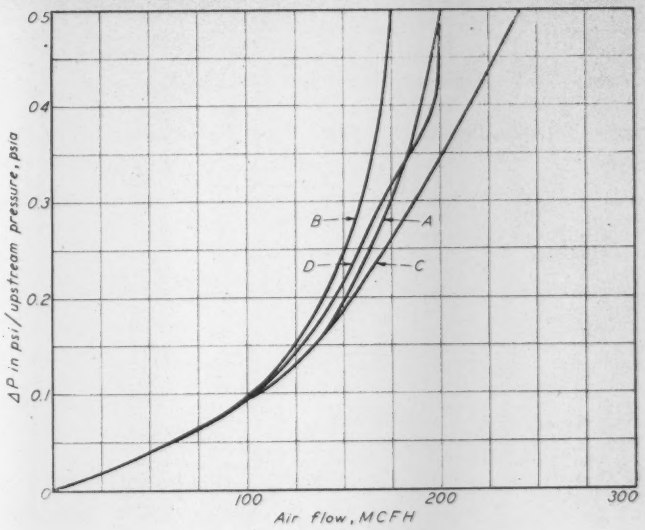


Fig. 11-1. Comparative capacity curves of a 2" 300-psi flanged-body valve with double-ported plug. Test medium: air. Curve A is true capacity; others show values calculated from formulae and charts as follows:

Curve A— Actual test data
Curve B— $Q = 1390\ C_v \sqrt{P_2 \Delta P/GT}$
Curve C— $Q = 1364\ C_v \sqrt{P_1 \Delta P/GT}$
Curve D— Fisher Alignment Chart

of valves adapted to this service. (A pressure drop of 150 psi or greater is assumed to be high.) Selection of a plug in a globe, angle, or S body may be advisable, and the type of plug and body may require special consideration. Use of valve actuators or valve positioners with high operating pressures and high power output makes pressure-drop limitations less severe.

Units

Be sure that the units used in stating flow are those used in the formulae. Liquid flows are given in gallons per minute at flowing temperature; air and gas flows are expressed in cubic feet per hour at specific gravity of 1.0 (referred to air = 1.0 at standard conditions—60°F and 14.7 psia); steam flow is designated in pounds per hour.

The flow formulae were given in chapter 2 and are repeated here:

Liquid

$$Q_L = C_v\sqrt{\Delta p/G} \qquad (4)$$

Dry Saturated Steam

$$Q_S = 3C_v\sqrt{P_2\Delta p} = 63.4\ C_v\sqrt{\Delta p/V_o} \qquad (5)$$

Dry Saturated Steam—Critical Flow

$$Q_S = 3C_v(P_1/2) = 1.5C_vP_1 \qquad (8)$$

Gas at Temperature T

$$Q_G = 1390C_v\sqrt{P_2\Delta p/GT} \qquad (10)$$

Gas at Critical Flow

$$Q_O = 1390C_vP_1/2\sqrt{GT} \qquad (15)$$

where Q_L is flow of liquid in U. S. gpm at flowing temperature
Q_G is flow of gas in scfh
Q_S is flow of steam in pounds per hour
Δp is pressure drop across valve in psi
P_1 is valve inlet pressure in psia (upstream)
P_2 is valve outlet pressure in psia (downstream)
T is absolute Fahrenheit temperature
V_o is specific volume of steam at inlet in cu ft/lb = 1/density
G is specific gravity at flowing conditions

Determination of C_v for Liquid

The C_v factor can be determined by use of the formulae given previously in this discussion. A valve size should be selected that passes the desired flow at the differential pressures available. Due to the arbitrary methods used by manufacturers in determining the C_v of their products (see Table 2-2 in Chapter 2) it becomes difficult sometimes to justify going to a valve one size larger when the C_v value desired is just slightly larger than the C_v of an available commercial valve. The engineer doing the sizing must decide if the maximum flow value is a true and accurate value, or whether the pressure drop could be slightly greater. In most cases the engineer is justified in using the smaller of two valves when the calculated or desired C_v is less than 10% higher than the difference between the C_v values of the two valves.

Determination of C_v for Gas Flow

The required C_V can be found from equation 10 and a selection made by referring to manufacturers' data. (Use of sizing charts available from manufacturers who obtained their data experimentally is a more accurate method.) Formula 10 uses downstream pressure; the formula also exists in a form that uses the upstream pressure P_1 rather than the downstream pressure P_2, as follows:

$$Q = 1364\ C_V\sqrt{P_1\Delta p/GT}$$

Mr. G. F. Brockett of Fisher Governor Co. presents a curve (Fig. 11-1) in his paper* "Correlation of Valve Sizing Methods" that compares flow calculations through a 2" valve using the upstream pressure (curve C) and downstream pressure (curve B). Curve A was obtained by experimental means. Curve D, obtained from Fisher sizing charts, is in close agreement with the test data. Although curve B shows as much as 14% lower flow at the critical-flow point, it justifies the use of the C_V formula with the discharge (downstream) pressure term, except for critical applications; this approach will always show a valve size that is adequate for the greatest flow at minimum pressure drop.

Determination of C_v for Steam Flow

Valve size for steam service can be determined using the C_v obtained by formula (5) given previously in this discussion. This formula applies to saturated steam. If the steam is either wet or superheated, a reduction in

*Presented before New Jersey ISA Symposium, April, 1952, and published in *Instruments*, June, 1952.

Table 11-1. Specific Gravities of Liquids and Gases

GASES	(referred to air)	LIQUIDS	(referred to water)
Acetylene	0.920	Acetic Acid	1.06
Air	1.000	Alcohol, commercial	0.83
Ammonia	0.592	Acetone	0.79
Butane (n)	2.085	Alcohol, ethyl	0.79
Carbon Dioxide	1.520	Alcohol methyl	0.81
Carbon Monoxide	0.967	Ammonia	0.89
Chlorine	2.423	Benzoic Acid	1.27
Dimethylamine	1.521	Carbon tetrachloride	1.60
Ethane	1.049	Chlorine	1.56
Ether Vapor	2.586	Ether	0.73
Ethylene	0.967	Gasoline	0.70
Fluorine	1.312	Glycerine	1.26
Helium	0.138	Kerosene	0.80
Hydrogen	0.069	Milk	1.03
Hydrogen sulfide	1.190	Naphtha	0.76
Methane	0.554	Nitric acid	1.50
Methylamine	1.080	Phosphoric acid	1.78
Methyl Chloride	1.785	Sulphuric acid	1.84
Methyl fluoride	1.195	Tar	1.00
Natural gas	0.570	Vinegar	1.08
Nitrogen	0.971	Water	1.00
Oxygen	1.105	Water, sea	1.03

valve capacity occurs. For example, if the steam is superheated by 200°F, the valve capacity or C_v is reduced by about 15%. However, most applications involve saturated steam.

In formula (5) the quantity (Q) is in pounds per hour. The same precautions in analyzing the system for pressure drop across the valve should be considered as for liquid flow.

Steam is a compressible fluid and as such conforms to the laws of critical flow—that is, no increase in flow will be obtained with a pressure drop more than about one half of the absolute upstream pressure. For example, if the upstream pressure is 150 psia and the downstream pressure is 50 psia, the formula for critical flow, not subcritical flow, must be used.

Specific Gravity

For accurate sizing it is important to consider the specific gravity of the flowing liquid, whether liquid or gas. Liquid gravity is based on water as 1.00; gas gravity on air at standard conditions (60°F and atmospheric pressure) as 1.00. Typical gas and liquid specific gravities are given in Table 11-1. Note that common fluids have specific gravities of wide difference—from hydrogen with a specific gravity of 0.069 to butane with a gravity of more than 2.0. As the gravity multiplier appears under the square-root sign in the sizing formulae, a 20% variation of liquid gravity causes a 10% change in C_v.

Temperature

The temperature correction factor is $\sqrt{T_o/T} = \sqrt{520/T} = 22.8/\sqrt{T}$. As described in Chapter 2, it is less than 6% between 0 and 130°F and can be neglected in this region unless high-accuracy calculations are being made.

Viscosity

Viscosity correction factors can be determined from the curves in Fig. 11-2, which are plots of correction factors vs a *viscosity index*. The product of a correction factor and the calculated valve orifice diameter (or calculated C_v) is the required size. The selected valve size must be the next larger nominal-sized valve-port available as determined from manufacturers' capacity tables.

The curves show that the correction factor is negligible for index values above 1000; also that the size of a valve does not change much with a viscosity index as low as 300. In most cases the difference between the desired valve size and the available commercial size is sufficient to take care of the effect of viscosity.

The Viscosity Index for liquid can be determined from the following formulae:

When viscosity is designated in stokes:

$$\text{Viscosity index} = 10{,}000\ Q_L/\sqrt{C_v} \times \text{Centistokes}$$

When viscosity is given in Saybolt Universal Seconds (SSU):

$$\text{Viscosity index} = 46{,}500\ Q_L/\sqrt{C_v} \times \text{SSU}$$

where C_v is the flow coefficient determined for the valve under the given conditions of flow, and Q_L is flow in gpm at flowing conditions.

Flashing Liquids

When the pressure drop across the valve is sufficient to reduce the downstream pressure below the vaporization point of the flowing liquid (at the temperature of the liquid at the higher pressure) a portion of the liquid will flash into gas, producing a 2-phase system—part liquid and part gas.

It is not difficult to visualize liquid flow through an orifice (valve) into an expanded pipe or vessel in a manner such that the additional vapor volume does not impede the flow. Here the flow through the orifice would all be liquid and would follow the laws of liquid flow. However, calculation of the effect of flashing on valve sizing—as well as on downstream piping size—is still a controversial subject and several different approaches are in use.

One accepted practice is to make the valve one size larger if temperature and pressure considerations indicate flashing in the valve body. The larger valve minimizes flow impedance due to friction and turbulence, but this obviously is a crude first approximation to the problem.

A second technique is to use a valve sized for the volume of liquid plus vapor that is calculated to exist on the *downstream* side of the valve. A standard formula for determining the volumes of liquid and vapor in the downstream mixture is

$$X = S(T_1 - T_2)/H$$

where X is the fraction of weight of fluid vaporizing; S is the specific heat of the fluid, T_1 is the upstream fluid temperature in degrees F; T_2 is the downstream fluid temperature in degrees F; and H the latent heat of vaporization of the fluid at the downstream conditions in Btu/pound. After thus determining the liquid flow and vapor flow, a C_v for each is calculated; these two C_v factors are then added to obtain the required capacity factor C_v.

A third practice is based on the assumption that a certain percentage of the vapor existing downstream from the valve is flashed in the valve body, and the port area is sized to accommodate the liquid flow plus this arbitrarily chosen percentage of flashed vapor (usually between 50% and 100% of the total downstream vapor).

A fourth approach* is reported by G. F. Brockett and

*Reported in the paper "Sizing Control Valves Handling Flashing Liquid," presented at 8th Symposium on Instrumentation in the Process Industries, Texas A&M College, Jan. 1953, and published in *Instruments*, July, 1953. A heat-balance technique is reported in a paper "Selection of Diaphragm Control Valves and Regulators," by Norman Lieblich of Kieley & Mueller, Inc.; paper was presented at Southwestern Gas Measurement Short Course at U. of Okla., 1952.

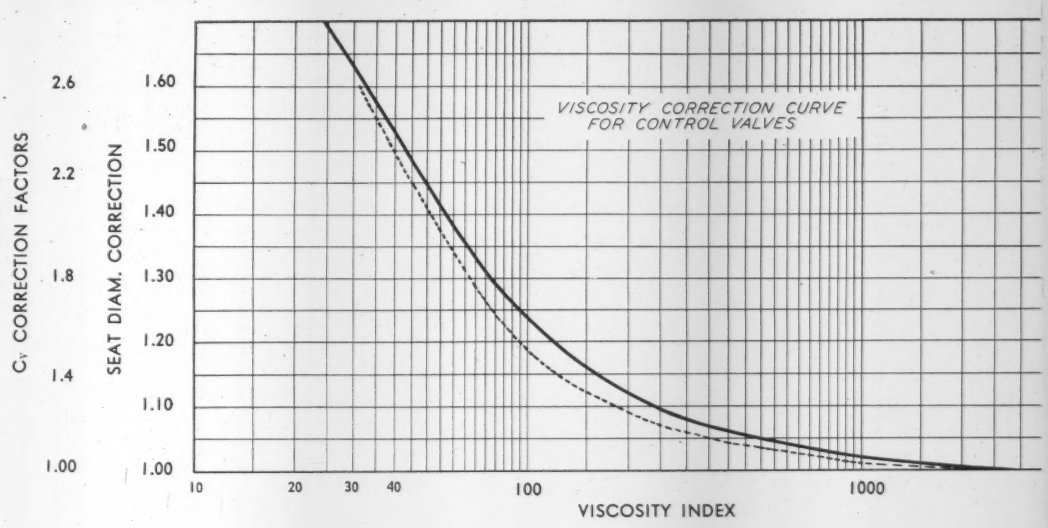


Fig. 11-2. Curves of correction factors vs viscosity index. Dotted curve gives C_v correction; solid curve applies to seat-diameter correction factor.

C. F. King of the Fisher Governor Company, who report that for water flowing through globe-style bodies there is an "apparent critical pressure drop" at which increase in pressure drop across the valve does not result in any increase in flow through the valve. This "apparent critical pressure drop" is found to be a function of saturation temperature and inlet temperature and gives a correction factor for flashing that is shown to be superior to conventional heat-balance methods—for globe bodies.

A fifth approach is to use the valve size calculated for liquid flow, but to use increased pipe size—starting at the outlet of the control valve and long enough to minimize the turbulence of flow. (The decision made some years ago by most manufacturers to discontinue making valves with outlet larger than the inlet is unfortunate. Valves of this type would find use for gas service as well as for flashing liquids.)

A sixth approach is to select a streamlined valve, thus minimizing the effect of the vapor. In this case again the valve is sized for the liquid flow. Attention is again called to the fact (as it was in considering viscosity effect) that the required coefficient C_v for maximum flow may be so close to the next smaller valve that the next larger size is essentially an expanded size compared with the required size.

Rangeability

Most curves showing the relationship between flow rate and percent valve opening show a positive, although small, flow at closed position. Actually, this measurement is taken with the valve slightly open. This is considered the minimum *controllable flow* of a globe valve using either V ports or a characterized plug (the type of valve used in a multitude of control jobs).

Most of these valves will operate under ideal conditions with a minimum flow of 1/50 of the maximum flow—that is, the valve has a *rangeability* of 50 to 1. Most engineering specifications call for a rangeability of 30 to 1 or more. Obtainable rangeability varies with the design of the valve from 100 to 1 down to a generally accepted value of 15 to 1 (for an unlined butterfly valve).

It becomes important in selecting a valve to determine whether or not the valve will control both the maximum flow at minimum pressure-drop, and the minimum flow at maximum pressure-drop. The relation between these two flows is the operating rangeability required.

Rangeability (R_v) for liquid flow is related to the *range* of flow rate and pressure drops as follows:

$$R_v = R_f\sqrt{P_{dp}}$$

where R_v = Maximum C_v/Minimum C_v, or rangeability
R_f = Maximum flow rate/Minimum flow rate
P_{dp} = Maximum pressure-drop/Minimum pressure-drop

In this case the C_v factor is the calculated value and not the C_v of the nominal-sized valve selected.

Example

Maximum flow rate equals 120 gpm at 5-psi drop.
Minimum flow rate equals 20 gpm at 20-psi drop.

$$R_f = 120/20 = 6$$
$$P_{dp} = 20/5 = 4$$
$$R_v = 6\sqrt{4} = 12$$

By reference to equation (4), the C_v for maximum flow is:

$$C_v = Q_L/\sqrt{\Delta p/G}$$
$$= 120/\sqrt{5/1}$$
$$= 53.5$$

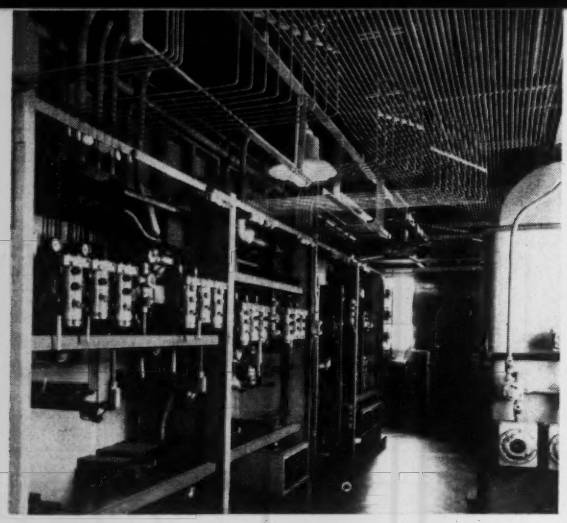
This C_v indicates a 2½" valve (with a C_v of 75). As the valve has a C_v of 75, and as a C_v of only 53.5 is required at the maximum flow rate, the valve will be only partially open. Its opening will be 53.5/75 or 0.714—or 71.4% open.

If the valve has a minimum controllable flow of 2%, and as it will be only 71% open at the required flow, a rangeability of 71/2 or 35 is available—whereas only 12 is required.

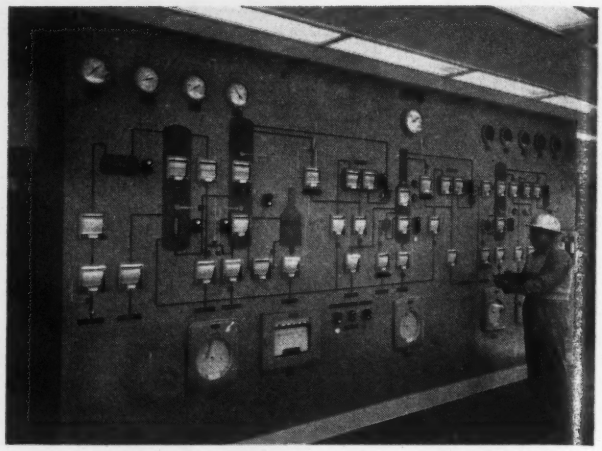
If it is desired to use a butterfly valve, a 1½" size with a C_v of 56 would handle the maximum flow. The maximum flow would be 53.5/56 or 96% of the actual valve capacity.

Assuming a minimum controllable flow of 7% for this type of valve, the rangeability would become 96/7, or 14, which still is acceptable.

Accumulation of correct operating data with flow and pressure limits is the vital factor in valve sizing. Wide variations occur between a valve size and the next larger or smaller commercial size; inasmuch as flow varies as the area (the square of the diameter), a small change in diameter causes a great change in flow capacity and in rangeability. For example, a 4" valve will handle almost twice the flow of a 3" valve. Hence *beware of oversizing.*



Back of TCC unit panel board showing stack-type pneumatic controllers and electronic controllers. Fluor instrument engineers favor self-supporting panelboards.



Operator check dials of panel board for light-ends fractionation unit in Texas.

The Importance of PIPING to

A GOOD industrial process instrument job consists of correct instrument selection for the specific applications coordinated with *properly engineered piping*. A good Piping Designer must know not only the function and operation of the instruments, but also the operating procedure of the plant during normal and abnormal conditions. As a preliminary guide to satisfy the instrument function and plant operation demands, the following four "Check Points" should be considered on instrument installations:

1. Pipe the instrument in accordance with the recommendations of the vendor or with good piping practice standards.
2. Locate the instrument, if a controller, so that it is accessible for manual operation for start-up or for emergency conditions.
3. Arrange the instrument so the dial or chart is visible from the nearest platform, walkway or manual control station.
4. In addition to accessibility, enough free space should be provided in front and in back of the instrument so that repairs and tests can be made conveniently, safely and quickly.

These four basic guides should be kept in mind at all times. In addition, the following rules apply to specific instrument types.

Thermometers

In use of Thermometers, the following items should be considered in connection with Check Point #1:

A. The well should penetrate far enough in the line to offset conductance of heat away from the well to prevent a false reading, especially on temperatures above 600°F.

B. The well should be located where the process fluid is not stagnant, so that a representative temperature can be obtained.

C. The line should be large enough so that the well penetration does not restrict the flow so that an excessive pressure drop develops.

Temperature instruments are checked frequently for accuracy and, in order to aid the maintenance men, accessibility is important.

Pressure Instruments

Pressure instruments differ from thermometers from a piping consideration. In piping a pressure instrument, the following points should be considered under Check Point #1:

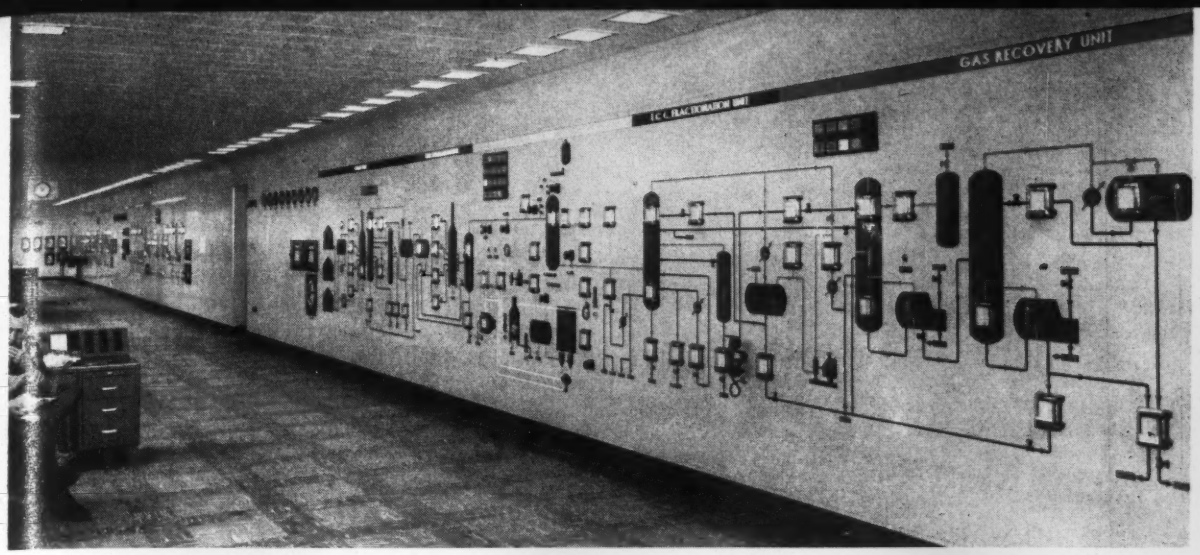
A. The tap should be located on top of the line so that mill scale, dirt, etc., do not fall into the sensing element or plug the lines.

B. The tap should be located at a point so that the desired pressure is sensed, not a "pseudo" one.

C. The instrument leads should be protected against the process fluid freezing or becoming highly viscous, or the heating of the sensing element.

Flow Instruments

A. The lengths of meter runs should be in accordance with the ASME or AGA recommendations. This ap-



Longest graphic panel board ever designed by Fluor instrument engineers follows complete refinery process. The board, measuring 165 feet in length, reflects complete refinery instrumentation in one control center, made possible by the fact that entire refinery is located at one site.

INSTRUMENTATION

JOSEPH CONISON
The Fluor Corporation, Ltd.

plies to orifice plates, pitot tubes, Venturis, flow nozzles, etc.

B. The piping manifold for the range and the float chambers as well as for the condensate or seal pots should conform to the vendor's recommendations.

C. Taps should be located above the bottom of the pipe so as to keep out mill scale, etc.

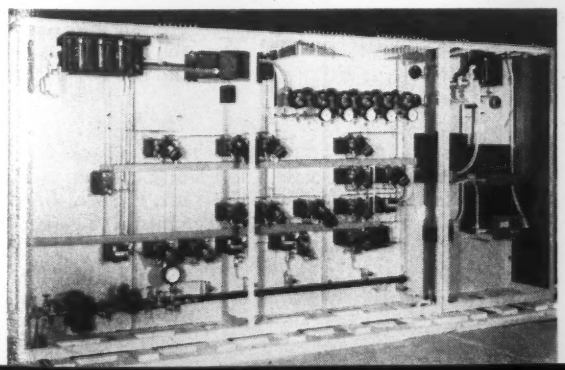
D. Seal against the process liquids freezing or vaporizing in the lines, or corroding the meter lines of the instrument.

E. Use condensate pots when large volume displacement occurs, as in mercury or bellows-type instruments used for steam or condensible-vapor services.

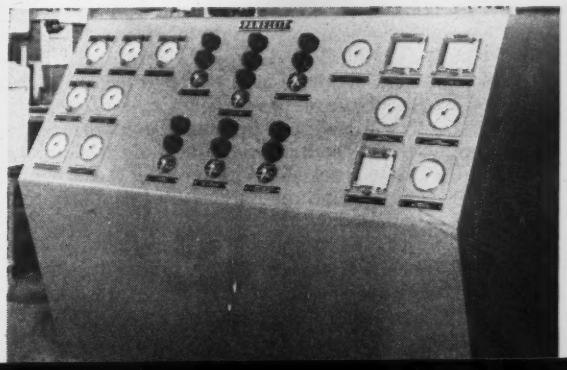
F. Allow enough space between piping on the pipe racks to allow for orifice tap piping, especially if side connections are called for.

G. The preferred location for meter runs is in a horizontal line. As an alternate for liquid service, vertical upward is preferred to vertical downward. In some cases on liquid service with downward flow the line may not run full. In services where gases contain condensible vapors, vertical downward flow permits the condensate to be blown through the orifice. In horizontal lines it is possible for the condensate to be trapped upstream from the orifice plate, unless drains or weep holes are provided. Where no drain or weep hole is provided, use of blowdown connections is recommended.

In this self-supporting panel board, stack controllers are mounted at angle to increase accessibility.



Large centrifugal compressor control board, including flow, pressure and safety override controls.



Two walls of control panels for power generating plant in Southern California.

Panelboard of fluid catalytic cracking facilities in western Canada.

Level Instruments

The following applies to gage glasses and external-float displacement controllers (which constitute about 95% of present level applications today).

A. The piping should be arranged so that the level instruments may be valved off for removal without shutting the unit down.
B. If required, provisions should be taken to prevent freezing, corrosion, or settling of solids.
C. Gage glasses and level control cases should face the walkway or the operating platform.
D. Clearance should be provided for opening the instrument cases.
E. Locate in sight of associated manual control valves.

Control Valves

A. The most important item to consider for an instrument-controlled or self-controlled valve is *accessibility*. The valve must be readily accessible (1) for manual operation of bypass on start-up and for emergency operation, (2) for repair or removal, and (3) to remove the bottom flange for checking the plug or removing the stem.
B. The preferred valve location is in view of the dial of the controlling instrument. If the piping arrangement dictates, then transmit the process variable pneumatically to a receiver located near the control-valve station.
C. The control valve assembly should be arranged so that the stems on the block and bypass valves do not protrude into the walkway but are accessible from the platform without use of ladder or auxiliary steps.
D. If the control valve includes a self-contained temperature bulb and capillary, the length of the capillary tubing should be checked before locating the valve on the piping drawing. Minimum length of capillary tubing should be used.
E. If the control valve is operated by a blind controller (such as a pressure pilot, or self-contained bulb and capillary) then a local indicator of the process variable should be mounted nearby as a check of the control.

Relief Valves

A. The piping of relief valves must conform to the API and API-ASME codes.
B. The inlet line size to the valve should be equal to or greater than the inlet nozzle of the valve. The outlet line should be equal to or greater than the outlet nozzle.
C. Only "locked open" block valves should be permitted between the vessel and the relief valve, and outlet header. Three-port two-way cocks are permitted when a spare relief valve is used. The piping should be arranged so that *one relief valve is always in service.*
D. When two or more safety valves are placed on one connection, the connection shall have an internal area equal to at least the area of the combined inlets of the relief valves.

Conclusion

Each check has a vital part in (1) fulfilling the satisfactory operation of the instrument, (2) making the plant operator's job easier and safer, and (3) encouraging the maintenance man to periodically test and repair the instrument. All this can be achieved for little extra cost by conscientious effort and setting up good standards on piping details.

Acknowledgement

The writer wishes to thank The Fluor Corporation for permission to publish this paper, and Mr. Cyril L. Griesbaum of Fluor for his constructive comments.

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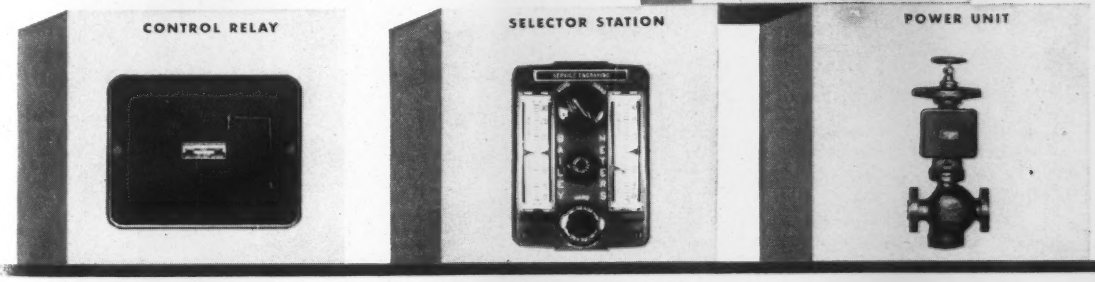

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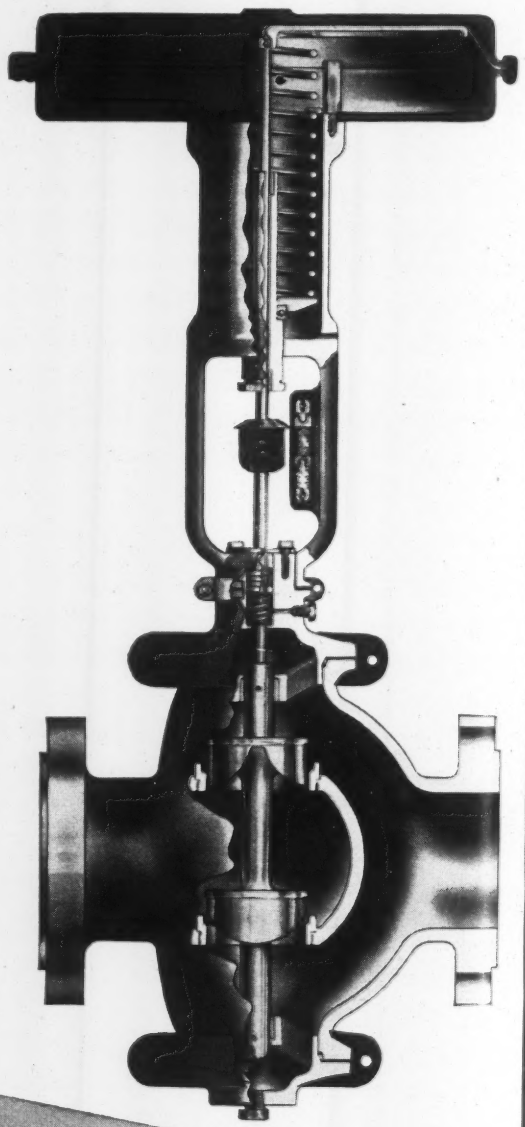

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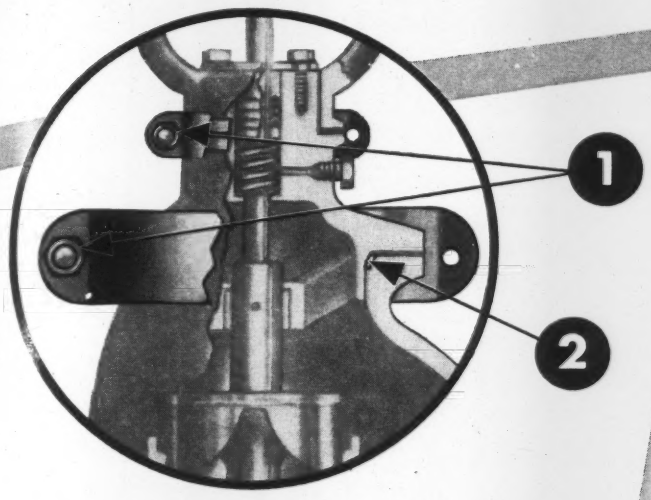

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DATA AND DECISION: USING ELECTRONIC COMPUTERS IN BUSINESS
Color, 35mm., sound, series of 4 strips
Review: Deals with development and business application of electronic digital computer. Each of four filmstrips is self-contained unit on how computer evolved, how it works, how to plan it and how to use it.
Source: Visual Education Dept., American Management Association, 1515 Broadway, New York 36, N. Y.
Avail: Four filmstrips are sold as a set.

THE TUBE OF TOMORROW
Color, sound
Review: Shows models of a micro-miniature power amplifier and of a voltage amplifier for guided missiles. Depicted are demonstrations of unique properties and characteristics of micro-miniatures in environments encountered in military use—including a simulated naval gunfire shock test.
Source: Tube Dept., General Electric Co., Schenectady 5, N. Y.

GLASS AND YOU
Color, 16mm., sound, 28 min.
Review: The story of glass, from its beginning 75,000 years ago as a molten volcanic mass, and its contributions to the arts, sciences, industry and world civilizations ever since.
Source: Corning Glass Works, Corning, New York.
Avail: Loan, pay return transportation charges, report showings and attendance.

GLASS FOR SCIENCE
Color, 16mm., sound, 38 min.
Review: Glass working methods in the production of glassware for laboratory use.
Source: Advertising Manager, Technical Products Division, Cornings Glass Works, Corning, N. Y.
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ADVENT OF ANESTHESIA
B&W, 16mm., sound, 9 min.
Review: This film re-enacts the first public demonstration of ether anesthesia at the Massachusetts General Hospital in 1846.
Source: Advertising Department, Mallinckrodt Chemical Works, 3600 North Second St., St. Louis 7, Missouri.
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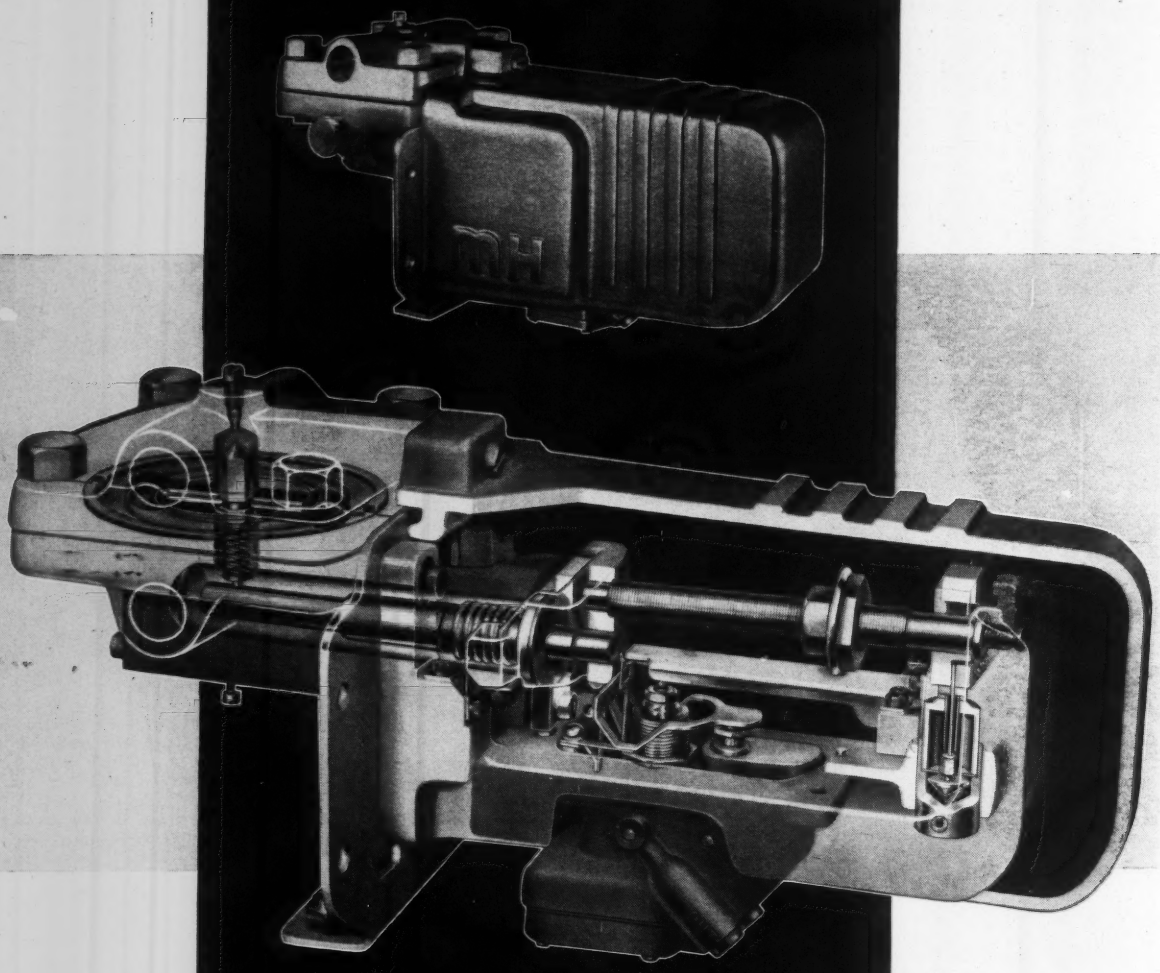

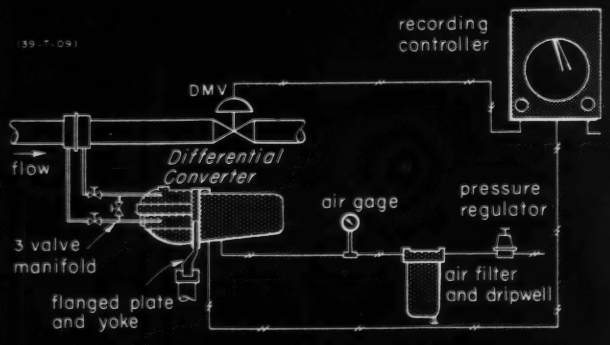

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● **REFERENCE DATA:** Write for Bulletin 2290-1, "*Differential Converter* Liquid Level Transmitter"; Catalog 2321 "Flow Meters"; and Specification 248, "*Differential Converter* Flow Transmitter".

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SOLID FILM LUBRICANTS

Solid film lubricants are finding increasing applications in the gas, oil, and chemical industries. Application, technique, surface pretreatment, operational factors and theoretical considerations are discussed.

RALPH E. CRUMP

Electrofilm, Inc.

BASIC TASKS of any lubricant are: (1) Separate the two rubbing surfaces, thus eliminating galling, seizing, or metal wear. (2) Reduce the energy needed for motion, by reducing the friction between parts. (3) Sometimes a lubricant is asked to act as a coolant, and a carrier for debris.

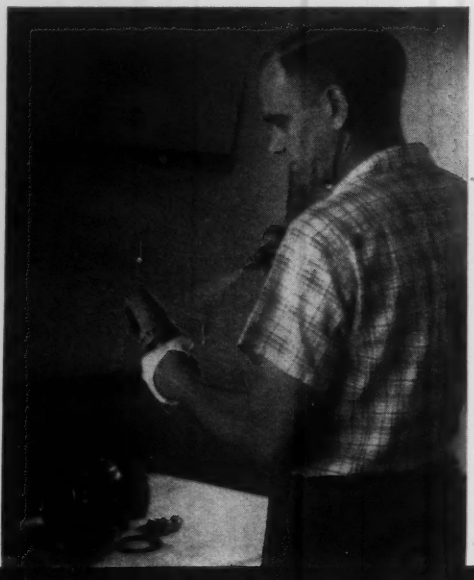
Lubrication is classically accomplished by providing a film between the two surfaces that are moving relative to one another.

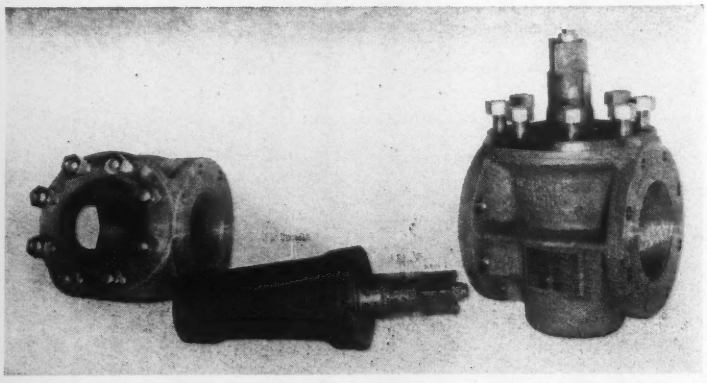
Few materials exist in nature or can be manufactured that "slip easily" and still possess the properties that allow them to be used to carry bearing loads, or that can withstand the rigors of high speeds. Therefore we must find materials that can be used as a film that will transmit loads and do the other jobs discussed above. These films have taken the form of liquids, semi-liquids, solids, and gases. It is the *solid films* that we wish to discuss in this article.

What are Solid Lubricants?

Lubrication by solid films is accomplished by combining, with certain binders, solid particles that are known to have lubricating properties. A few of these solids are: graphite, molybdenum disulphide, tungsten disulphide, lead oxide, certain of the iron oxides, and other metallic oxides. There are two current theories suggesting how these solids lubricate:

(1) One theory is based on an adsorbed layer of water vapor in the case of graphite, and a sulphur layer





Typical parts that have been processed with solid film lubricants, and application with a spray gun.

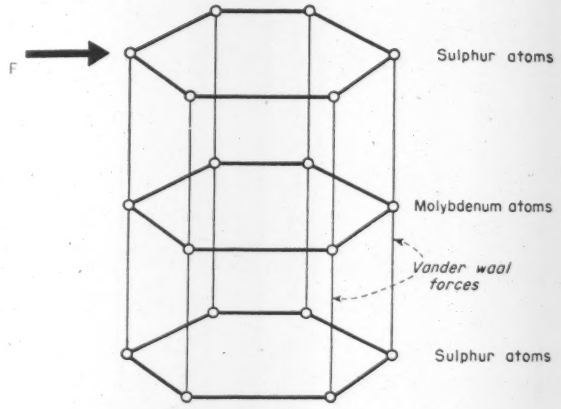


Fig. 1. Graphical representation, crystal structure of molybdenum disulphide. Low shear strength and low coefficient of friction is a result of atomic forces on each plane being stronger than those between planes.

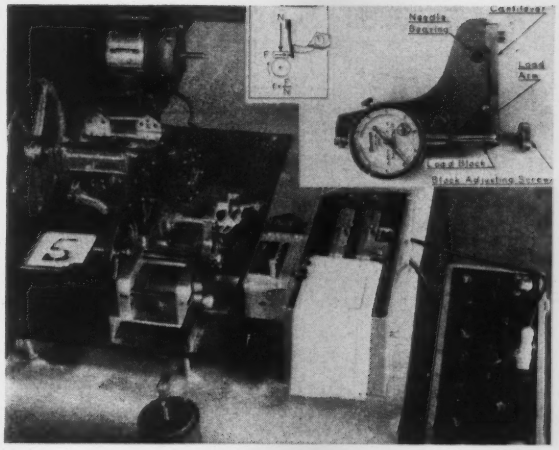


Fig. 3. Modified MacMillan tester for measuring frictional properties of solid film lubricants. Strain gages are attached to a cantilever arm which deflects in proportion to the friction force.

in the case of moly disulphide; the adsorber layer thus providing the lubrication.

(2) The other theory is based on the unique crystal structure of these solid lubricants, which is laminar latticed.

The crystal structure of a widely used pigment (solid lubricant), molybdenum disulphide, is shown graphically in Fig. 1. The interatomic forces on each plane are much greater than the forces between planes, resulting in a low shear strength between planes and, therefore, a low coefficient of friction.

Even though particles are in random orientation in a solid film, as soon as two coated surfaces are rubbed together the particles are forced into alignment. This is evidenced as an increase in reflected light on an initially opaque coated surface, and is commonly called "burnishing."

How are Solid Lubricants Applied?

The care and technique employed in applying a film decides the performance to a large extent. In general, the surface to be coated should have a surface finish of 32 to 62 microinches rms. The irregularities increase adhesion and provide for a better chemical pretreatment, if one is specified. Process charts (Fig. 2) specify preferred surface treatments for various metals. One advantage of the need for a rough surface before application is that finishing operations such as grinding and honing often can be eliminated.

The dimensional change immediately following this treatment depends on the metal, its hardness, and the processes used. For steels the change is usually less than 0.00005 inch, which is negligible in most applications.

Most metals then must be chemically processed to increase the corrosion resistance and provide a chemical etch and/or a deposit that will enhance adhesion and wear life. A typical example is the iron manganese phosphate conversion defined in the Military Spec. C-12968. Fig. 2 also suggests conversions for other metals.

The solid film lubricant can be applied either by spraying or by dipping. The choice depends on desired coating characteristics and wear requirements. Thickness usually can be controlled more accurately by spray gun

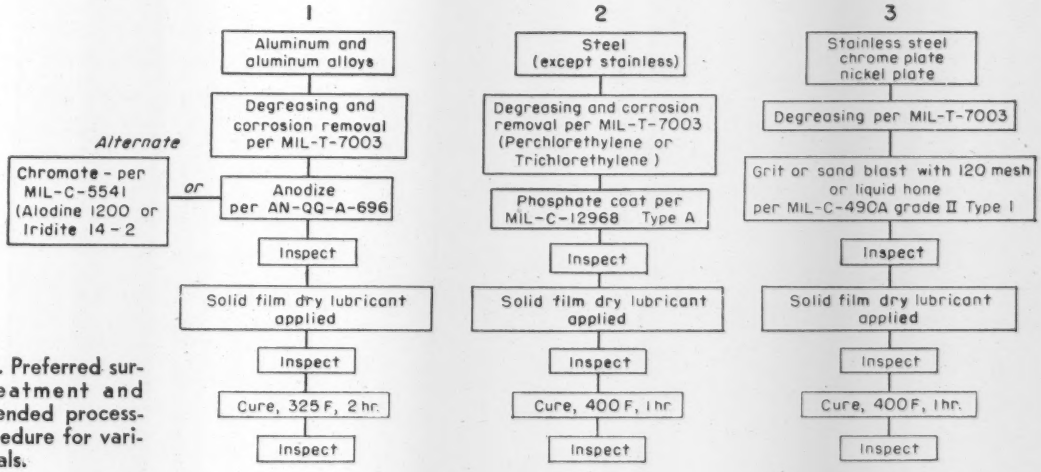


Fig. 2. Preferred surface treatment and recommended processing procedure for various metals.

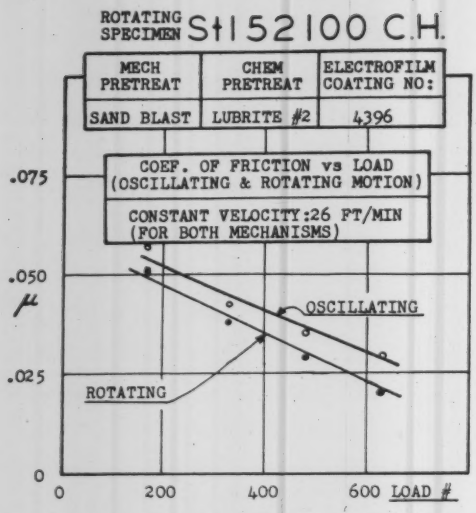


Fig. 4. Coefficient of friction of a solid film lubricant vs load for rotating and oscillating motion.

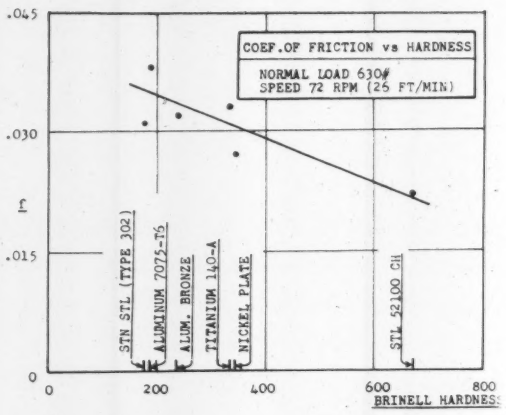


Fig. 5. Coefficient of friction vs hardness of various metals, rotating specimens.

than by other methods. By controlling the solids content, and pressure, a coating can be deposited to within $\pm$ 1/2 of one ten thousandth of an inch in thickness. A properly applied film should be no more than 0.0005″ nor less than 0.0002″ for good wear life.

As most films are compounded of thermosetting resins, they must be cured at temperatures high enough to polymerize the resin. Adhesion, coefficient of friction, and wear life are directly proportional to the degree of polymerization.

Cleanliness is essential. Many plants have installed continuous processing equipment that includes degreasing, chemical etch with the attendant rinses, pretreatment tanks, automatic spray equipment, and infrared ovens, with parts moving on an endless belt.

Frictional Properties

Coulomb, in 1781, first distinguished between static and kinetic friction.

Since the time of the early researchers, the causes of friction have been investigated with respect to atomic and molecular attraction, electrical field attraction, and the interlocking of surface asperities. These notions have gradually given way to the present day thinking that the friction (F) in a system is directly proportional to the shear strength (S) of the softer material and the contact area (A):

$$F = SA \qquad (1)$$

and that the actual contact area A varies directly with the applied load L and inversely with the flow pressure of the softer material. As the flow pressure is approximately equal to the metal hardness H (in appropriate units), equation (2) will take the form

$$A = L/H \qquad (2)$$

The classical definition for the coefficient of friction μ is that it is the ratio of the friction force and the normal load.

$$\mu = F/L \qquad (3)$$

therefore, rearranging equation (2) we get

$$\mu = F/L = SA/HA = S/H \qquad (4$$

with the area cancelling out, showing the coefficient o friction to be independent of contact area, but dependen on the shear strength and the hardness of the softe material in a friction system. In the case of solid film lubricants the film provides the low shear strengt (approx. 2.4 x 10^2 psi at high loading) by virtue o the solid lubricants used. It is apparent that a 0.0003″ thick film can support little load in itself, therefore th loads must be borne by the elastic and plastic stresse of the metal to which the lubricant is applied.

Frictional properties of solid-film lubricants have bee measured on the equipment shown in Fig. 3. Briefly, i consists of a modified MacMillan test machine that use a friction head with strain gages attached to a cantilever which deflects in proportion to the friction force. The strain gages are coupled to a recording oscillograph which can be arranged to record friction force as a func tion of load, speed, motion, etc. Thus, knowing the fric tion force and the load applied to the test specimen, the coefficient of friction can be calculated.

Fig. 4 plots the coefficient of friction of a standard solid film lubricant with increasing load, for both rotating and oscillating motion. The values of μ for oscillating motion appear to be approximately 10% higher than rotating values at all loads studied. This is probably due to the fact that those lubricating particles located at the surface are reoriented each cycle in the oscillating mechanism, whereas if the motion is undirectional (rotational) the surface particles remain fairly constantly oriented.

Table 1 lists frictional values for several solid film lubricants, applied to several metals.

General Statements

1. μ decreases with increasing load.
2. Kinetic coefficient of friction μ will decrease slightly with increased velocity.
3. Static values of μ are always higher than kinetic. No static values were measured above 0.1.
4. Data indicate that two hard surfaces with solid film lubricant between them is the superior arrangement, both frictionally and wear life-wise. (This of course is contrary to accepted design practice in conventional lubricants.)
5. Data indicate that the rule of not using similar metals in plain and rubbing bearing applications may be

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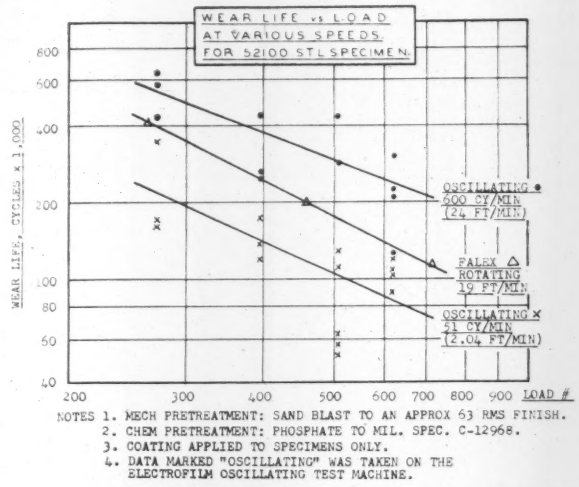


Fig. 6. Wear life vs load at various speeds for 52100 ST. specimen, for both oscillating and rotating motion.

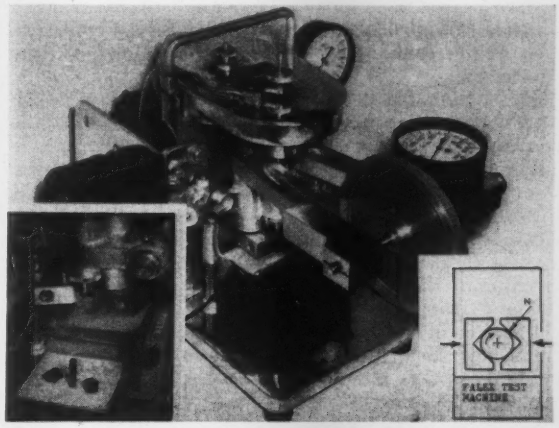


Fig. 7. Test machine for measuring wear-life data.

ignored when using solid film lubricants. Friction and wear life seem to be more concerned with metal hardness than with similarity. This is particularly brought out in our work on stainless steel and titanium (two normally bad actors).

6. If a choice must be made between processing the hard or the soft surface in a hard-soft bearing arrangement (i.e., steel against aluminum bronze), the softer metal should be processed.
7. Coefficient of friction is always lower for unidirectional motion than for oscillating motion. This is probably due to the fact that in oscillating motion the surface particles are reoriented each cycle, resulting in a slightly higher frictional force.
8. The changes in μ with regard to temperature are small. Compared to the changes in μ and viscosity in oils and greases, solid film lubricants are affected negligibly by a large change in temperature.
9. μ for solid film lubricants will always decrease during the run-in. The steady-state values will be lowest for highest loads.
10. In general the coefficient of friction is higher when both surfaces are coated (as compared to one surface only). It should be borne in mind, however, that wear life for both surfaces coated is considerably longer than for one.
11. Generally it is better design practice to process the moving part rather than the stationary one, except when the "mover" is smaller (i.e., small piston in cylinder); then the larger area should be processed.

It was observed, as we tested various metals, that the coefficient of friction seemed to increase with the softness of the metals tested (see Fig. 5). We therefore measured the hardness of the actual metals and reduced these numbers to an index common to all, namely the Brinell number. Fig. 5 shows the coefficient of friction as a function of the Brinell number. It should be kept in mind that data were taken at constant load and at constant speed, the loading block (in all cases) was bare case-hardened steel, and the coating tested in all cases was Electrofilm's 4396. This bears out the fact that solid film lubricants allow us to lubricate a system where both members are hard. Needless to say, this is contrary to design practice using conventional lubricants.

How Long will Solid Lubricants Last?

Wear life is a function of load, speed and temperature, and is affected by film thickness, humidity, film com-

Table 1—Summary of Coefficient of Friction

Coating #	Rotating Specimen Metal	Load Block—Bare	Coefficient of Friction*
4396	52100 C. H. Steel	4130 C. H. Steel to R_c 60	.023 kinetic
4396	52100 C. H. Steel	Aluminum 75ST	.04 kinetic
4396	Stainless Steel (303)	4130 C. H. Steel to R_c 60	.032 kinetic
4396	Titanium 140A	4130 C. H. Steel to R_c 60	.035 kinetic
4396	Aluminum Bronze	4130 C. H. Steel to R_c 60	.035 kinetic
4396	Aluminum Bronze	Aluminum 75ST	.032 kinetic
4396	Chrome Plate	4130 C. H. Steel to R_c 60	.033 kinetic
4396	Chrome Plate	Aluminum 75ST	.042 kinetic
4396	Nickel Plate on 52100 Steel	4130 C. H. Steel to R_c 60	.030 kinetic
4396	Nickel Plate on 52100 Steel	Aluminum 75ST	.034 kinetic
4396	Aluminum 7075-T6	4130 C. H. Steel to R_c 60	.035 kinetic
4396	52100 C. H. Steel	4130 C. H. Steel to R_c 60	.072 static
4356	52100 C. H. Steel	4130 C. H. Steel to R_c 60	.087 kinetic
4856	52100 C. H. Steel	4130 C. H. Steel to R_c 60	.09 kinetic

NOTE: *All kinetic values at approximately 26 feet per minute.

COMPARISON DATA

Steel on steel	0.45-0.60	Dry
Brass on steel	0.44	Dry
Babbitt on mild steel	0.33	Dry
Glass on glass	0.4	Dry
Steel on steel, MoS_2 in silicone varnish	0.06	Ref NACA Tech Note 2802
Steel on steel-graphite, bonded	0.17	Ref NACA Tech Note 1578
Steel on steel with E. P. Oil	0.042	Boundary Lubrication
Lubrite on steel with SAE 10 oil	.082	
Lubrite on steel	.168	Dry

position, metal pretreatment, properties of the metal to which the film is applied, and various ambient conditions such as the presence of oil, contaminants, or oxidizing atmospheres.

Fig. 6 plots the wear life (a function of the total volume of material applied) of a standard film of solid lubricant for various loads, for both oscillating and rotating motion. The oscillating test data were obtained from a machine similar to that shown in Fig. 3, fitted with an attachment that allows the test specimen to oscillate under load rather than rotate. The wear-life data marked "Falex" in Fig. 6 were obtained from a test machine as shown in Fig. 7.

Fig. 8 plots the wear life of a solid film lubricant as a function of rubbing speed, showing endurance to increase (to some limit) with increasing speeds. This is probably due to the fact that at these speeds (1 to 25 ft/min) the coefficient of friction is velocity-dependent—i.e., it decreases with increasing velocity. As it has been previously pointed out that wear life is a function of the coefficient of friction, it is apparent how surface speed could influence wear life. It should be noted in Fig. 8 that at the upper speeds, the actual wear life data drops off. This probably is due to the fact that no attempt was made to control the temperature of the test specimen, and as the surface speeds increased, the surface temperature increased, which would have a tendency to cause the endurance of the lubricant to decrease.

Fig. 9 plots wear life for five metals whose hardness varies considerably.

In general, maximum wear life can be obtained by irregularizing the surface to approximately 64 microinch finish prior to the application of the lubricant.

Where to Use Solid Film Lubricants

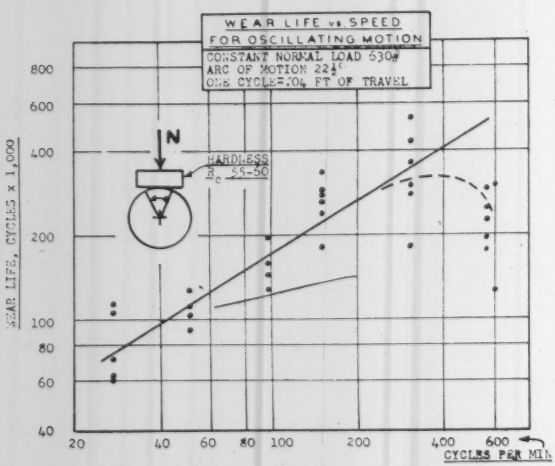
Conditions or factors dictating the use of solid film lubricants are listed below:

1. Impending galling and seizing of mating surfaces due to insufficient film strength of the boundary lubricants. Certain metals are particularly susceptible to galling; aluminum and titanium are good examples.
2. Bearings, either inaccessible or likely to be overlooked on a lube schedule. Hermetically sealed units.
3. On non-continuous operating systems where maintenance schedules are expensive over long periods.
4. Where lubrication dependent on oils or greases is impaired due to temperature—i.e., film strength lost at high temperatures, high coefficient of friction at low temperature. Solid film lubricants are independent of temperature between the ranges of −100° to +600° F., with special films available for temperatures higher than 1000° F.
5. Systems failing due to fretting corrosion. Solid film lubrication will not eliminate fretting corrosion, but it can delay the start of it for periods of time that often exceed the life of the part. Ref. 4, N.A.C.A., found that bonded films of solid lubricants can delay the start of fretting corrosion (steel ball against glass flat) up to 28,000,000 cycles.
6. Equipment located in environments reactive to conventional fluid lubricants such as fuels, certain solvents, liquid oxygen, etc.
7. Where adjacent parts, or saleable products, become contaminated with excess liquid lubricants dripping or rubbing off.
8. Where dust, plus other airborne debris, impairs operation. Solid film lubrication is dry, does not attract dust, lint, etc.

Of particular interest to the chemical industries is the fact that these lubricant films can be made impervious to the following fluids. *Distilled H_2O, Tap Water, Skydrol, MIL-O-5606, MIL-H-3136, MIL-C-3278, *Dioxane, Xylene, *Trichlorethylene Liquid-Vapor, Liquid Oxygen, *Silicone Fluid DC 200, *Jet Engine Oil MIL-O-6081, *Gas Turbine Oil MIL-O-7808.

*Immersion test in this fluid was followed by having the solid film lubricant rubbed with two cloths soaked in Trichlorethylene and Dioxane, with no damage resulting to the film. All tests were immersed for 24 hours.

Fig. 8. Wear life of a solid film lubricant vs rubbing speed.



NOTES 1. MECH PRETREATMENT: SAND BLAST TO AN APPROX 63 RMS FINISH.
2. CHEM PRETREATMENT: PHOSPHATE TO MIL. SPEC. C-12968.
3. COATING APPLIED TO SPECIMENS ONLY.

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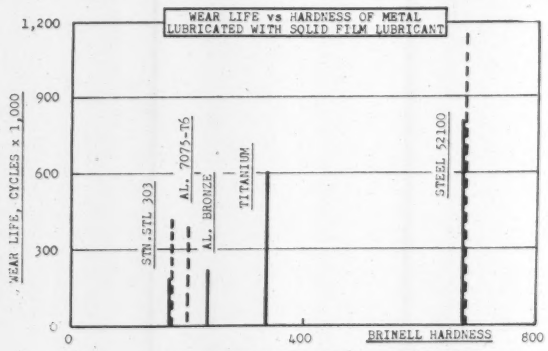
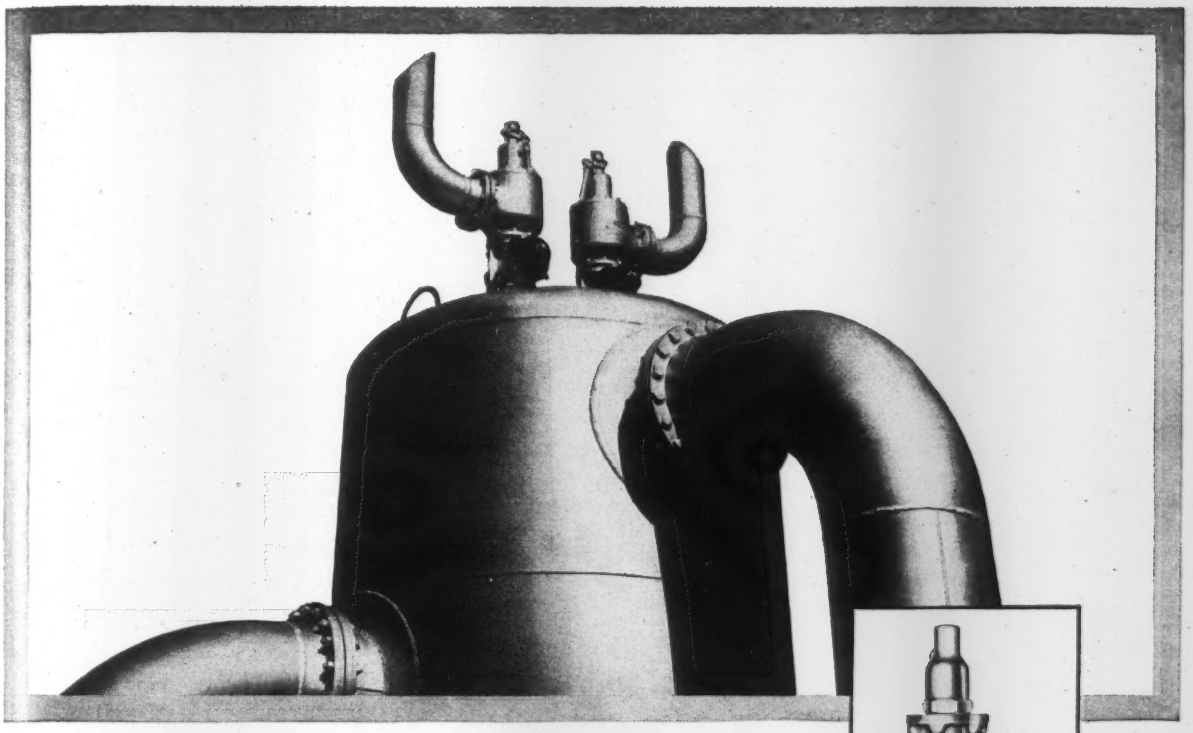
1. Ralph E. Crump: Solid Film Lubricants—Factors Influencing Their Mechanism of Friction and Wear. ASLE Paper No. 56LC-3.
2. J. F. Archard: *Journal of Applied Physics*, April 1953.
3. Ernest Rabinowicz: Relation Between Friction and Wear for Boundary-Lubricated Surfaces. *Phys. Soc. Proc.*, Sept. 1955, Vol. 68, No. 429-B.
4. Douglas Godfrey and Edmond E. Bisson: Effectiveness of Molybdenum Disulfide as a Fretting-Corrosion Inhibitor. NACA Technical Note No. 2180.

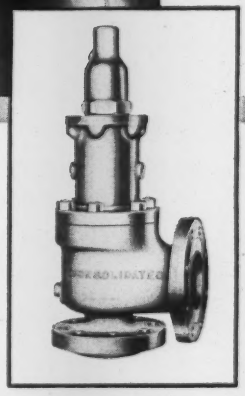
Fig. 9. Wear life vs hardness of metal.



METAL	MECH PRETREAT	CHEM PRETREAT
STN.STL 303	SAND BLAST	HCl ETCH
AL. 7075-T6	SAND BLAST	See note 4
AL. BRONZE	SAND BLAST	OXIDE #2
TITANIUM	SAND BLAST	NONE
STEEL 52100	SAND BLAST	PHOSPHATE #1

NOTES 1. OSCILLATING MOTION: 20° ARC @ 180 CYCLES PER MINUTE. WEAR LIFE INDICATED BY SOLID LINE.
2. ROTATING MOTION: 72 R.P.M. WEAR LIFE INDICATED BY DASH LINE.
3. ALL TESTS RUN WITH STEEL BLOCK, R_c 55-60.
4. ALODINE 1200 PER MIL. SPEC C-5541.





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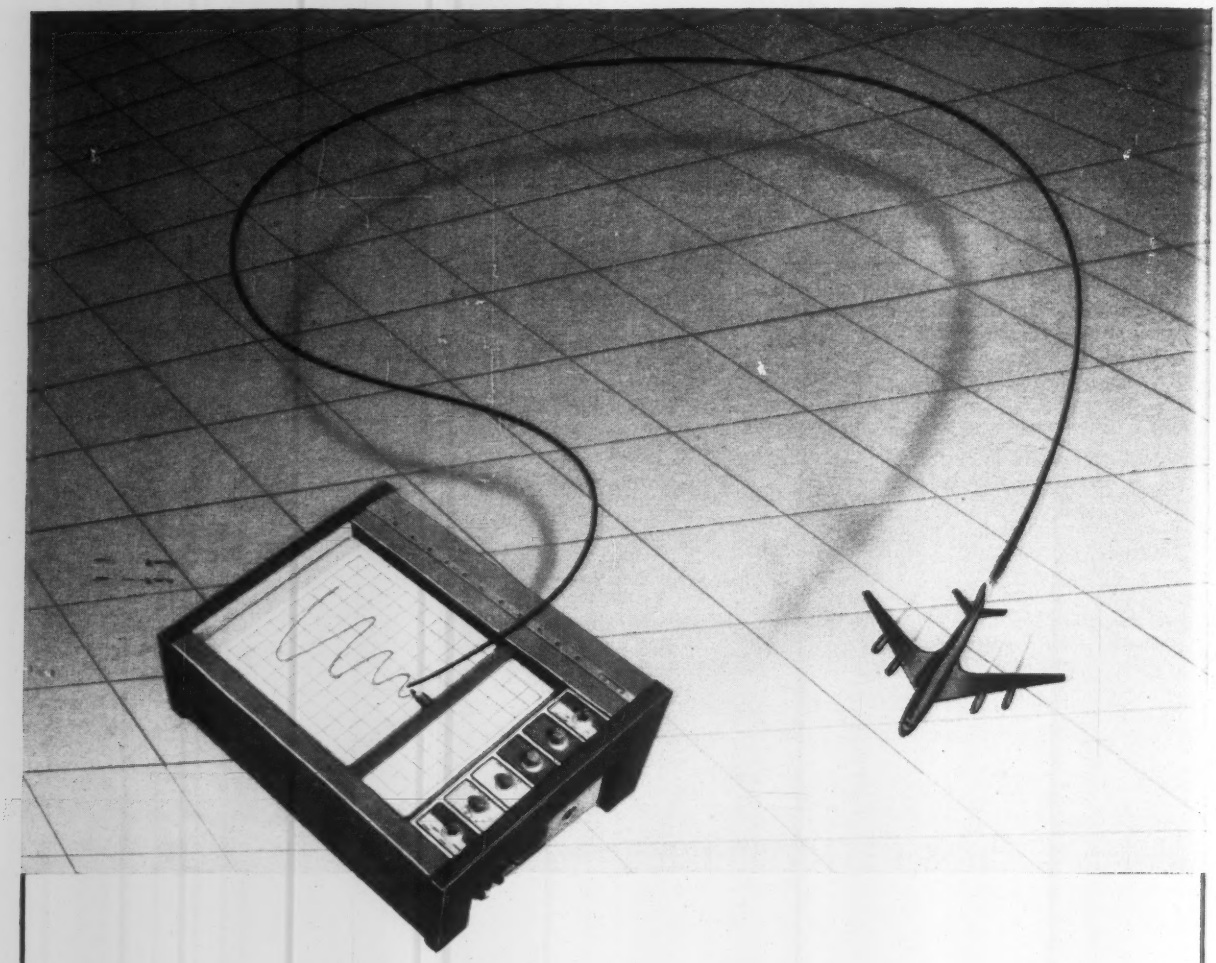

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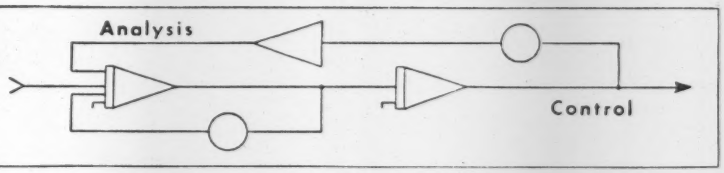
The SIMULATION COUNCIL Newsletter



John H. McLeod, Jr., EDITOR

Suzette McLeod, SECRETARY

8484 LaJolla Shores Drive
LaJolla, Calif.

Western Simulation Council
Jack Sherman, Missile Systems Division, Lockheed Aircraft Corpoartion, Van Nuys, Calif.; Chairman, Steering Committee.

Midwestern Simulation Council
A. C. Robinson, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio; Chairman, Steering Committee.

Eastern Simulation Council
Frank Richmond, Glenn L. Martin Co., Baltimore, Md.; Chairman, Steering Committee

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W. K. McGregor, ARO, Inc., Tullahoma, Tenn.; Chairman, Steering Committee.

Central States Simulation Council
Jim A. Pierce, Beech Aircraft, Wichita, Kan.; Chairman, Steering Committee.

BITS

Noise is annoying, we all agree. When we don't want it we often can't get rid of it; when we want it we might have to generate it ("Take one small child . . ."). Then we must measure it to see what we've got. Usually we find it isn't right so we have to change it. If we finally get it right, how do we use it? If you'd like to know what some authorities have to say on the subject, read Bernie Loveman's notes under "Pieces."

Also under "Pieces" you will find Norm Irvine's preliminary report on the organizational meeting of the Central States Simulation Council, and a description (based on info supplied by Stan Rogers) of the last meeting of the DDA Council.

PIECES

EASTERN S/C MEETING OF 16 JULY ON "NOISE IN SIMULATION"

Approximately 58 members representing 28 organizations met at the Princeton Computation Center to attend the ESC meeting of 16 July 1956 on "Noise In Simulation." Six study groups met during lunch.*

Favreau Defines Noise

To Favreau (Princeton Computation Center, Electronic Associates, Monmouth Junction, N. J.) gave an "Introduction to Noise" in which he described its important characteristics.

Noise is a random variable—i.e., given the signal up to a certain time, it is impossible to predict what the signal will be thereafter. One example is the output of a receiver having zero input. In order to consider the statistical properties of noise we must consider an ensemble of such signals —an infinite number of signals produced by receivers operating under identical conditions. The statistical characteristics at a given time may then be defined:

The probability density function is defined as the probability of finding the signal at a specified voltage. The probability is plotted as a function of voltage from minus infinity to plus infinity. The area under this curve must equal one because there is unity probability of finding the signal between the infinite limits.

The cumulative distribution function (CDF) is the probability that the signal lies below a given value; it too is plotted as a function of the voltage from minus infinity to plus infinity. In general the CDF is bounded by zero at minus infinity and one at plus infinity.

A *stationary random signal* is one for which the statistical characteristics do not vary as a function of time. In addition, the ergodic hypothesis states that the ensemble averages are the same as the time averages. This is helpful if you have only one receiver available.

Because of the unpredictable nature of noise, a frequency response for the signal is not meaningful. However, the power to be found in a unit frequency interval can be determined. This is called *the power spectral density* $G(f)$, and for a voltage signal the units are usually volts squared per cycle per second. Note that the power spectral density gives no information on the phase relations between the various frequency components.

Another way to describe the frequency properties of a random signal is by means of the *autocorrelation function* $R(\tau)$ which is defined as

$$R(\tau) = \lim_{T \to \infty} \frac{1}{T} \int_0^T x(t)\,(t+\tau)\,dt$$

where $x(t)$ is the random signal.

The spectral density $G(f)$ and the autocorrelation function $R(\tau)$ are different ways of defining the same property of a random signal.

*For a summary of their discussions, see "Info."

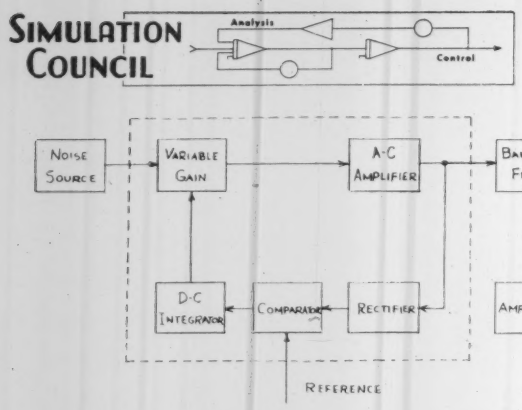

Fig. 1. Gas thyratron noise generator.

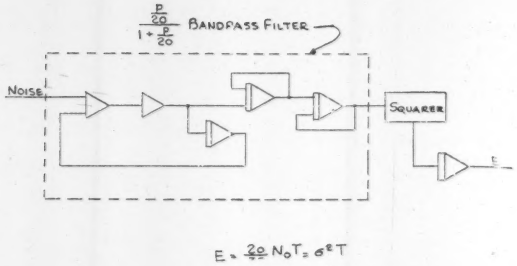

Fig. 2. Measurement of power spectral density.

It may be shown that

$$G(f) = 4\int_0^\infty R(\tau)\cos 2\pi f\tau d\tau$$

and similarly from the power spectral density

$$R(\tau) = \int_0^\infty G(f)\cos 2\pi f\tau df.$$

One term which is used rather loosely is "purely random" signal or "white" noise. For this signal a statistical description cannot be given for future points even if all the past history of the signal is specified. The power spectral density of such a signal will be uniform and have infinite bandwidth and therefore infinite energy. Naturally such a signal does not exist. The usual simulation procedure is to assume that the noise generator has a much wider bandwidth than the system to which it is applied. Then the frequency limitations of the noise source will not affect the system output.

In most simulation problems the random signal will have a normal or Gaussian probability density function. This particular distribution,

$$P(x) = (1/\sigma\sqrt{2\pi})\exp[-(x-\bar{x})^2/2\sigma^2]$$

where $\bar{x}$ is the mean and σ is the standard deviation, behaves very nicely with respect to linear systems —i.e., when noise with a Gaussian probability distribution is introduced into a linear filter, the output will also be Gaussian. Note that only two parameters are required ($\bar{x}$ and σ) to define a normal distribution. Thus with a known Gaussian noise input it is only necessary to determine two parameters to define the statistical output of a linear system.

In measuring the statistical properties of noise there are statistical accuracy limitations as well as measuring equipment errors to be considered. For example, in determining the probability density function, 10 or 20 points will give a rather rough histogram. It takes a very large number of points to get a smooth function. The measurement of the mean of the signal with normal distribution is another example of statistical limitations to accuracy. One way to make the measurement is to integrate the signal. In this case the accuracy of the measurement increases only as one over the square root of the integration time.

Connolly on a Thyratron Noise Generator

Tom Connolly (Electronic Associates) described a thyratron noise generator used at the Princeton Computation Center. The original development was done at Hughes Aircraft and is described in Project Cyclone Symposium I, p. 83. The unit is commercially available from Electronic Noise Generator Company, Los Angeles, Calif.

A 2D21 gas thyratron is used as the primary noise source. Its output is amplified, rectified, and integrated to produce a signal to stabilize the power in the frequency band from 30 cps to 3 KC. The noise is then fed to a bandpass filter having a bandwidth of approximately 400 ±35 cps. A chopper demodulator removes the 400-cps component and is followed by a low-pass filter which removes the higher harmonics. A block diagram of the system is shown in Fig. 1.

The output is monitored by a meter, the movement of which is immersed in a silicon fluid for damping, giving a time constant of several minutes. The output noise has a Gaussian distribution with a power spectral density at low frequencies of approximately $N_o = 4$ volts squared per cps. The mean value of the noise is less than 50 millivolts. The spectral density is flat ± 0.1 db from zero to 35 cps.

Measurements were made to determine the mean and the power spectral density. The former is measured by integrating the noise generator output for T seconds. If the integrator output after this time is E volts, then the mean is:

$$.m = (E/T) \pm 2\sqrt{N_o/2T}$$

To measure the mean to an accuracy of ± 30 millivolts, the integration time must be four hours. The power spectral density is determined by feeding the noise through a bandpass filter. This output is then squared and integrated. Typical integration time is 1800 seconds. Fig. 2 shows a schematic.

Hermann on the Goodyear Generator

Paul J. Hermann (Goodyear Aircraft Corp.) described the Goodyear noise generator. The basic idea is to generate a symmetric square wave for which the zero crossings are random with the duration of pulses having a Gaussian distribution. This signal can be used with analog-computer circuits to generate not only Gaussian but other random-amplitude distributions.

The first noise generator contained a radioactive source, Geiger-Muller Counting Tube, multivibrators, etc. Operating experience showed that the system had disadvantages—(1) low tube life, (2) expensive components, (3) lack of stability.

So they built a noise generator using a gas tube in a permanent magnetic field. Fig. 3 shows a block diagram. The output of the thyratron is amplified and triggers a blocking oscillator; its output is a series of pulses having Gaussian distribution. The multivibrator and feedback loop are used to regulate the mean counting rate. The flip-flop and buffer amplifier control the feedback impedance of d-c amplifier A. Electronic switches 1 and 2 operate alternately. The output of amplifier B is a symmetric square wave; its period has Gaussian distribution.

The noise generator has a uniform

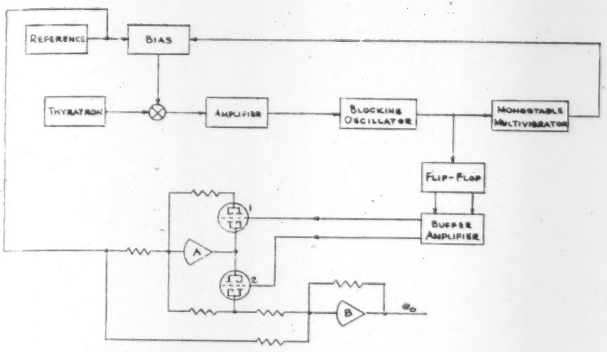

Fig. 3. The Goodyear noise generator uses a gas tube in a magnetic field.

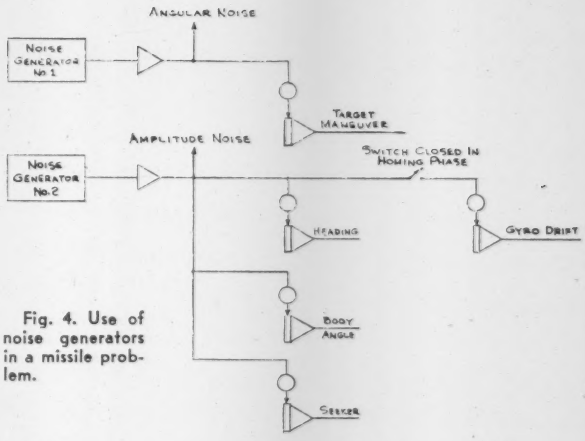

Fig. 4. Use of noise generators in a missile problem.

frequency spectrum from 0.01 to 10 radians per second.

Seifert on Servo Evaluation

Bill Seifert (Massachusetts Institute of Technology, Cambridge 39, Mass.) discussed the use of random signals in evaluation of servo performance. Bill pointed out that the standard techniques for evaluating servo performance are (1) frequency-response methods in which amplitude and phase shifts are plotted against frequency, and (2) transient methods, in which the response to step or velocity inputs is measured. However, the input which a servo is normally required to follow is random in character rather than a sinusoid or step. Therefore it is desirable to study high performance nonlinear servos by using random inputs.

Getting a good noise source is difficult. At MIT their gas-tube noise source has the usual long-term drifts. To overcome this the noise was recorded on magnetic tape as it was monitored and adjusted manually to give a stable result. This recorded noise is used for servo measurements.

Also required is a method for measuring the RMS value of the random signal. At MIT they rectify the signal and then pass it through a long time-constant filter. For Gaussian noise the filter output is a measure of the RMS value.

Bill described how the response to a random input may be used to evaluate a servo with simple nonlinearities.*

Rubin on Missile Simulation

Art Rubin (Electronic Associates) described the application of noise generators to a typical simulation of a guided missile. Radar introduces two types of noise in guided missiles: angular noise as a result of multiple reflections from the target, and amplitude noise due to atmospheric disturbances. These random signals are uncorrelated.

Other noise generators are also required because some of the inputs to the system are random variables. These include: (1) initial heading, (2) seeker error, (3) body angle error, (4) gyro uncertainty (amount of drift is a random variable), and (5) target maneuver.

Random signals are required to establish the initial conditions for these variables. The first three initial conditions have correlated values.

Fig. 4 shows how two noise generators may be used for random variables in the pitch plane of a three-dimensional missile problem. A similar circuit is required for the yaw plane.

* For details see M. V. Mathews, "A Method for Evaluating Nonlinear Servos," *Applications and Industry*, AIEE, May 1956.

CENTRAL STATES S/C ORGANIZATIONAL MEETING, 15 OCTOBER 1956

Norm Irvine (Mid-Century Instrumatic Corp.) write us: "Today's organizational meeting of another section of the Simulation Council was a roaring success. The technical session held in the morning (10:00 AM) drew much discussion from the floor and from many individuals, not just a few. More about this later from the secretary.

"Some of the pertinent facts which I can present with reasonable assurance of accuracy are as follows: Elected Officers

James A. Pierce—Beech Aircraft, Wichita, Kansas, Chairman of the Steering Committee for 6 months

Arthur C. Cotts—Midwest Research Institute, Kansas City, Missouri, Secretary for one year

Vice-Chairman and Treasurer, if necessary, to be elected next meeting.

"An elected Steering Committee as follows: *Bruce Estes* (McDonnell Aircraft, St. Louis, Missouri); *L. N. Freeman* (Phillips Oil); *Jack L. Moon* (Kansas State University, Manhattan, Kansas); *Harry B. Cordes* (Boeing Aircraft, Wichita, Kansas)."

DDA COUNCIL, 15 OCTOBER 1956, ON "STABILITY OF DIGITAL SOLUTIONS"

The DDA Council held their third meeting at Litton Industries in Beverly Hills, Calif. on Monday, 15 October. Some 50 people gathered to hear and participate in a panel discussion, "Stability of Digital Solutions," which was led by *Max Palevsky* and *Roy Kier* (both of Bendix Computer). Charts prepared at the University of Pennsylvania and showing effects of various algorisms for integration or solutions were considered.

The group held a short business meeting which resulted in the election of *Stan Rogers* (Convair-San Diego) as first Chairman of the Steering Committee*. Previously he had been elected Chairman pro tem.

A show of hands on several topics proposed for discussion resulted in "Simulation of Digital Differential

*Stan was the second to be elected to the same position by the original Simulation Council.

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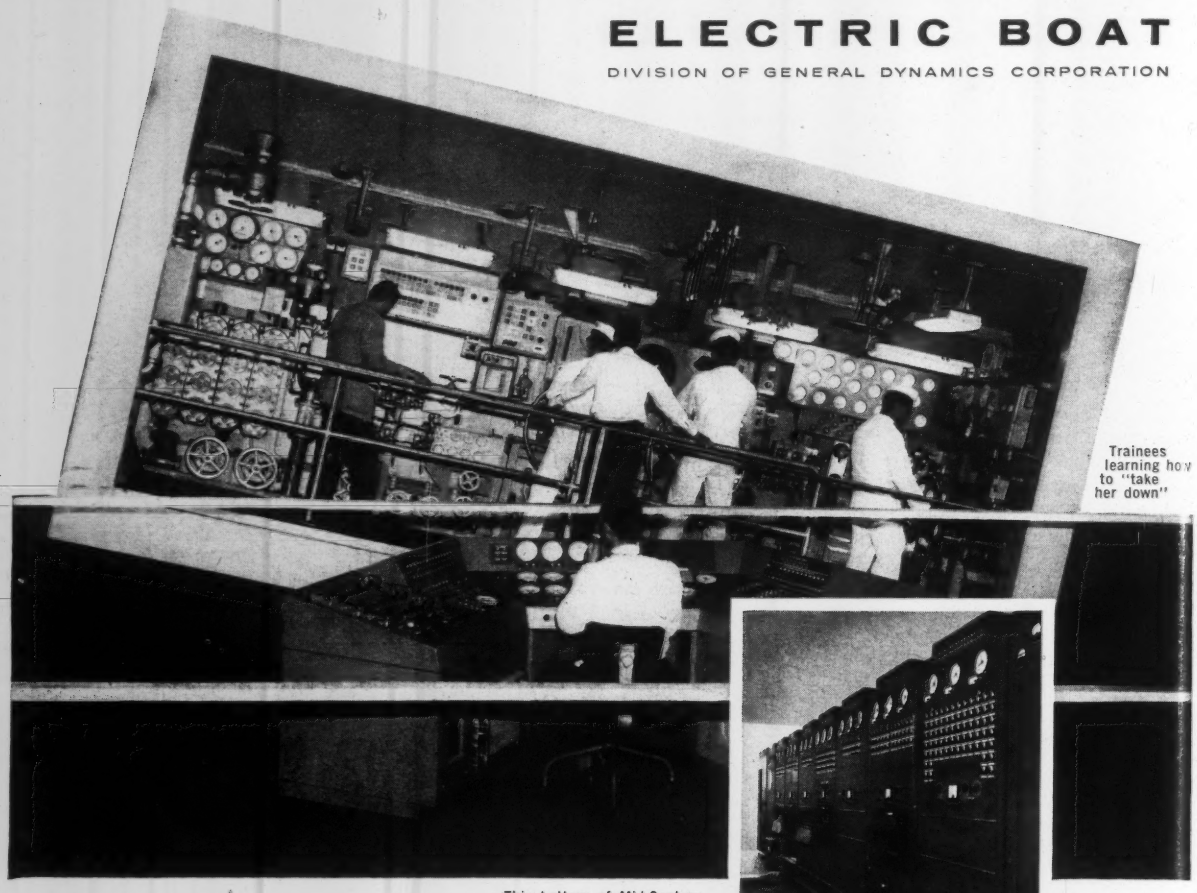

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Analyzers on General-Purpose Computers" being the subject of the afternoon session.

A tour of the Litton plant concluded the meeting. Construction of the Litton 20 "a marvel of miniaturization," was shown, but Your Editor understands that a "space suit" designed to allow the wearer full mobility under atmospheric pressures as low as 1 mm 10g stole the show. "Just like Buck Rogers!"

Information (Without Theory)

Many of us who are concerned with simulation and related subjects have been interested in the activities of some study groups initiated by the Eastern Simulation Council. Here is a summary of their July 16th luncheon meetings:*

Physical Simulation

Thirteen members representing nine different organizations attended the Physical Simulation study group (*H. Wexler*). Their discussion included:

1. Simulation of random gusts,
2. simulation of human operator,
3. transducers, and
4. three-axis simulators.

Operations Research

Nine members representing five different organizations attended the Operations Research study group (*J. Strong*). Three of these organizations—Electronic Associates, Johns Hopkins, and Reeves—have work in O.R. actually in progress. At Johns Hopkins both analog and digital computers have been used to solve O. R. problems. E.A.I. and Reeves have constructed special computers for linear programming and simultaneous equations. The group talked about:

1. The difference between optimization problems that are static (e.g., linear programming) and those that are dynamic;
2. Limitations of analog computers for O.R. problems:
3. Special O.R. analog computers compared to manual calculations.

Dead Time Simulation

Nine members representing seven different organizations attended the Dead Time Simulation study group (*C. Loveman*), and considered the following techniques:

1. Transfer functions,
2. tape recorders, and
3. electro-mechanical storage elements.

The group discussed the amount of time delay and the response to step and sinusoidal inputs of these units. Also mentioned were the lack of standards for evaluation of time delay specifications and of a good bibliography on the subject.

Analog Recorders

Eight members representing seven different organizations attended the Analog Recorder study group (*J. Lehman*) and discussed recording on magnetic tape. Both Electronic Associates and Rensselaer Polytechnic Institute have recorded analog quantities in the form of time division pulses. Accuracies of 0.1% have been achieved.

Transfer Functions

Seven members representing six different organizations attended the Transfer Function study group (*H. Mori*) and discussed the simulation of transfer functions with a minimum number of amplifiers. The group also considered the need for a network to simulate a quadratic transfer function with pole determined by dial settings.

Noise Study

Twelve members representing ten different organizations attended the noise study group (*R. Favreau*). Discussion centered around the characteristics of noise generators and theoretical results to be expected from those with AGC.

* * *

SOUTHEASTERN SIMULATION COUNCIL

Bill Bradley (Murphy and Cota, Atlanta, Ga.), Secretary of the SSC, writes:

"The next meeting of the Southeastern SC will be held in Atlanta, Georgia, on December 5 and 6 in conjunction with the Atlanta IRE Conference and Exhibit.

"A Steering Committee Meeting will be held at 11.30 AM, December 5th, at Remond's Restaurant.

"The Technical Meeting will be held Wednesday night at the ODK Dining Hall, at Georgia Tech. This meeting will begin at 6:30 PM. Subject of this meeting will be 'Error Analysis in Analog Computations'.

"Our host for this meeting will be Lockheed Aircraft Corp., Georgia Division, Marietta, Ga. Mr. W. C. Bennett will represent Lockheed as host. A tour of the Lockheed Plant for Thursday morning, December 6, from 9:00 until 11:00 AM for all Simulation Council members has been planned."

* * *

Your Editor and Secretary enjoyed a letter from *Fred Dixon* (Georgia Institute of Technology, Atlanta, Ga.) which reads in part:

"I can't help saying here that the described remarkably sudden turn of events to yield a condition assumed by John McLeod in the first place makes one wonder if he isn't in league with some supernatural agency or force, other than the Air Force. It is of course known that many strange cults exist in California, such as Convair, NAMTC ,etc., but I would never have believed till now that their high priests could attain such powers of divination or influence. We should probably not delve too deeply into this matter (after all, I have a family) but simply request that you substitute Mr. Prince's name for mine in the advance registration list . . ."

The next time anyone doubts the veracity of our crystal ball we're going to show them Fred's letter!

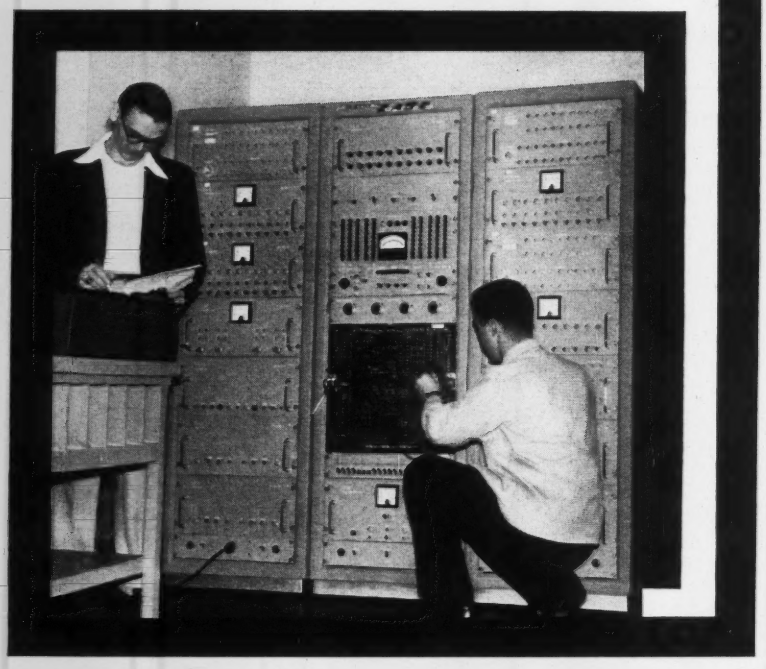
* * *

Combined Computation

As you well know if you have read this strip before, there has of late been much interest in combined analog and digital systems because the two methods complement each other and together are much more powerful than either alone.

Under the general subject "the ABC's of DDA's" those attending the next meeting of the DDA Council will learn about another combination of computers which should also offer many advantages: the combination of a General-Purpose Digital Computer and a Digital Differential Analyzer as exemplified by the Bendix GPC & DDA (See ad, p. 1869 September *I&A*). Appropriately enough, Bendix Computer Division, 5630 Arbor Vitae, Los Angeles will be host for this

* Vernie Loveman wishes to express his appreciation to the chairmen (names in parentheses) for their interest and help in preparing these notes.



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Georgia Tech's Analog Computer Laboratory had another reason for existence — the training of graduate students in computing theory and technology, an area in which **analog** concepts are a **must.**

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meeting in January. Bendix will also have a clinic class on the GPC & DDA at the TIAE.

Want to be Host for a DDA Meeting?

The DDA Council considers itself a national organization, but so far the meetings have all been held on the West Coast. So they would be interested in hearing from any of you elsewhere in the country who have or are interested in Digital Differential Analyzers, especially if you would like to sponsor a meeting of the DDA Council. You can get in touch with Stan Rogers at 3023 Alcott Street, San Diego, Calif.

* * *

Saw Grace Hopper at MIT and was amused by a story she told on herself. Seems she, a renowned mathematician, couldn't balance her check book for three months straight. She sought help from her brother—an investment banker—who, after careful analysis, discovered that she had on various occasions lapsed into binary arithmetic!

Thot

(By Bill Schart, Convair-San Diego)

"The analog computer" to quote Dr. Schart, "is a bunch of morons with hoses transferring water from tank to tank. They are given instructions from the control panel on what each one will do and how fast to work.

"Every morning the morons are given a workout to see if any are missing and if all are able and willing to do the work within their job rating. This is analog checkout."

Computer Events

Southeastern Simulation Council
Date: 5 and 6 December 1956
See detailed description under "Information (Without Theory)"

Central States S/C
Date: 10 December
Time: 10.00 AM
Place: Midwest Research Institute, 425 Volker Boulevard, Kansas City 10, Missouri
Subject: "Function of Two Variables"—All-day session (i.e. until 3 or 4 PM)
Contact: Arthur C. Cotts at the Institute. No Security Clearance required!

NATIONAL S/C MEETING

New York Trade Show Bldg. Rooms 633 and 635

Wednesday, 28 November 1956

1300—Midwestern Simulation Council Meeting. Milt Warshawsky will set the stage for a discussion of the trend in simulation equipment by describing unique features of the new simulation facility being built for Wright Air Development Center.

1445—Western Simulation Council Meeting Stan Rogers (Convair-San Diego) will put forth ideas on "Simulation and Computer Techniques to Come."

1700—Cocktail Party
No Speeches, no planned entertainment—just an opportunity to enjoy tall drinks and tall tales with old friends and new.

Thursday, 29 November 1956

1400—Southeastern Simulation Council Meeting

1445—Eastern Simulation Council Meeting Program will be developed about a discussion of "Simulation of Time Delays."

1700—Business Meeting of the National Simulation Council. A chairman for the Steering Committee of the National Simulation Council must be selected and plans for the next year will be discussed. All who are interested in the Council's work are invited, but only two authorized representatives from each Council will have votes.

Each of the Councils will be responsible for arranging and conducting their regular meetings. All who are interested in the particular subject to be discussed, or in the modus operandi of the Simulation Councils in general, are urged to attend and participate.

Thursday, 29 November
Business meeting of the Eastern Simulation Council at 1545, Reeves Instrument Corporation, 215 East 91st Street, New York, preceded by a tour of the Reeves plant. There will be luncheon meeting of the ESC study groups. Tour is at 9 A.M., business meeting 10 A.M.

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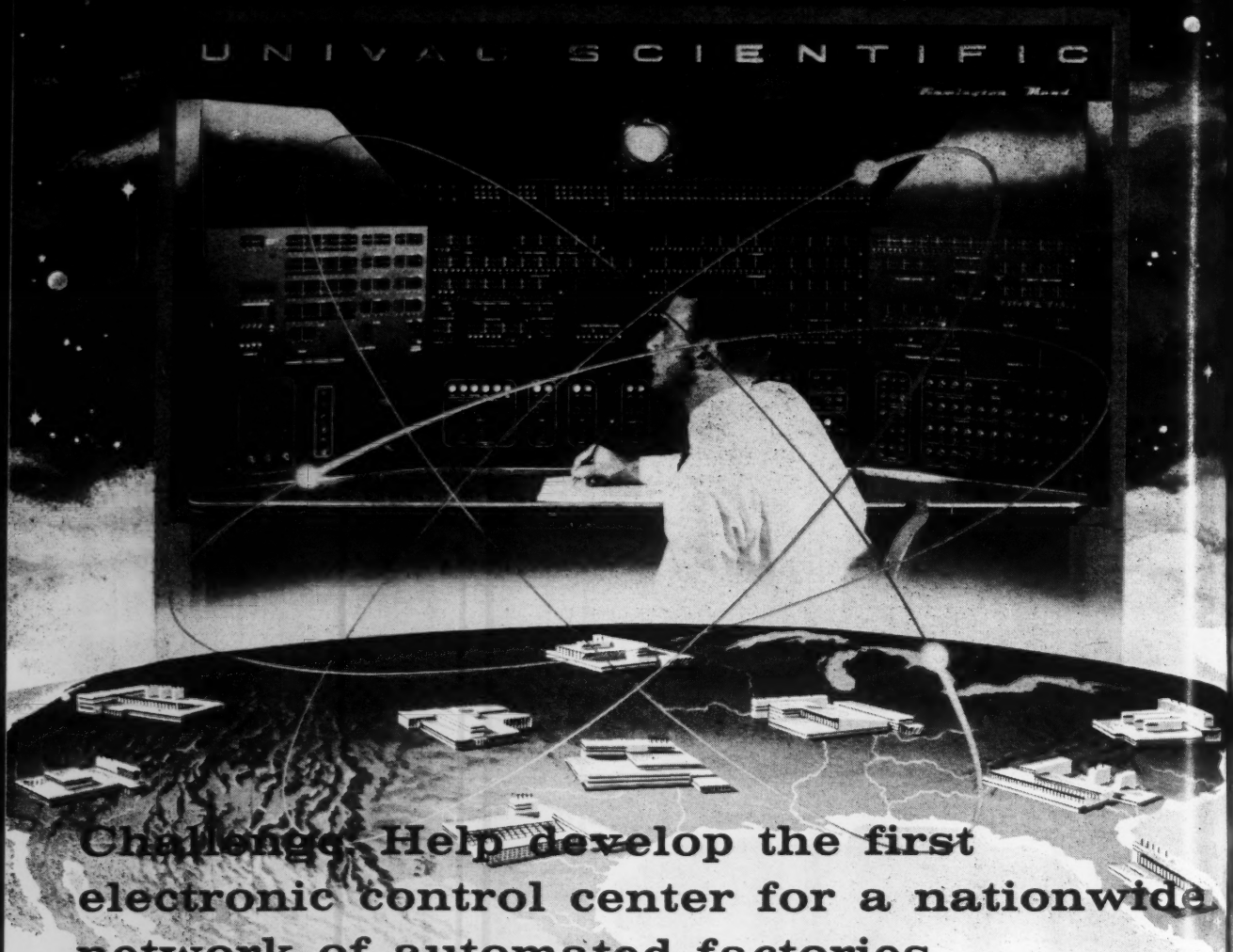

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Hagan Ring Balance Meter integrates data used to compute charges for air conditioning of Gateway Plaza Restaurant at Gateway Center, Pittsburgh

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Yes, and then some. The Hagan Ring Balance Meter can do the work of a meter, recorder, computer and controller—simultaneously! Basically, it's a simple mechanical device that measures the flow of any gas or liquid, but its applications in industry are almost limitless.

- *For a central air-conditioning plant*, it measures the exact amount of cooling supplied to each customer, at the same time computes how much each is to be billed.
- *For utilities and their customers*, the Hagan Ring Balance Meter measures the volume of flowing gases or steam or water. It makes accounting easier for both supplier and user, because it measures and records accurately. Its records can be used directly for billing.
- *In a large chemical plant*, it measures varying amounts of both water and alcohol in a flowing, mixed solution, and records the quantity of pure alcohol.

The Hagan Ring Balance Meter is so versatile that it can record up to four measurements simultaneously; measure specific gravity or density; automatically correct for temperature or pressure changes; integrate multiple flow data; and activate controls automatically.

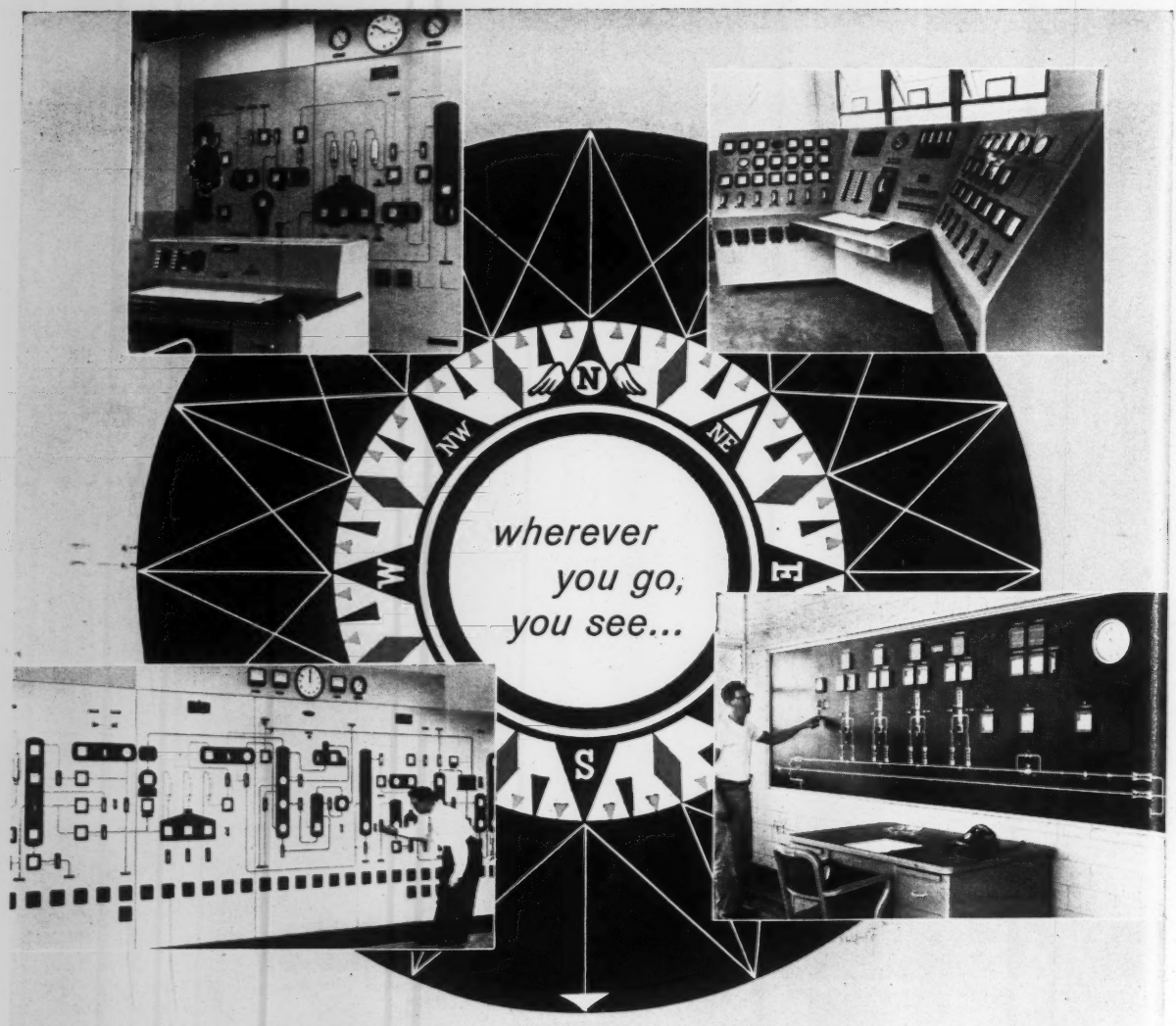
This rugged yet sensitive instrument is typical of the advanced aids to industry which Hagan provides . . . in such varied fields as combustion and process control, force measurement, and industrial water conditioning.

Write for detailed information on Hagan Ring Balance Meters, included in our brochure of products and services. Ask for Bulletin GSP-901.

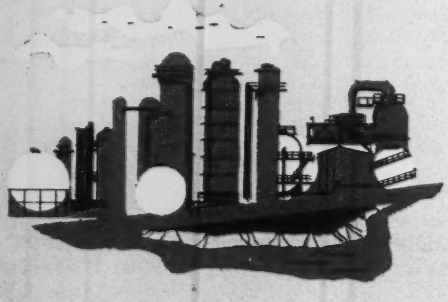
HAGAN

HAGAN CORPORATION
CHEMICALS AND CONTROLS
Hagan Building, Pittsburgh 30, Pennsylvania
Subsidiaries: Calgon, Inc. • Hall Laboratories, Inc.

For more information circle **68** on inquiry card.



Swartwout AUTRONIC® CONTROL SYSTEMS



Refineries . . . processing plants . . . nuclear installations...pipelines—wherever you go, you'll find Autronic controls by Swartwout, pioneer and leader in the *all-electronic* control field.

That's because wide-awake, cost-conscious plant operators know that the Autronic System can do the jobs other systems can't do . . . can do the ordinary jobs better, faster and frequently at lower cost. And now the Swartwout line is fully rounded out with controllers, indicators, recorders, sensing and control elements to do most jobs *best*.

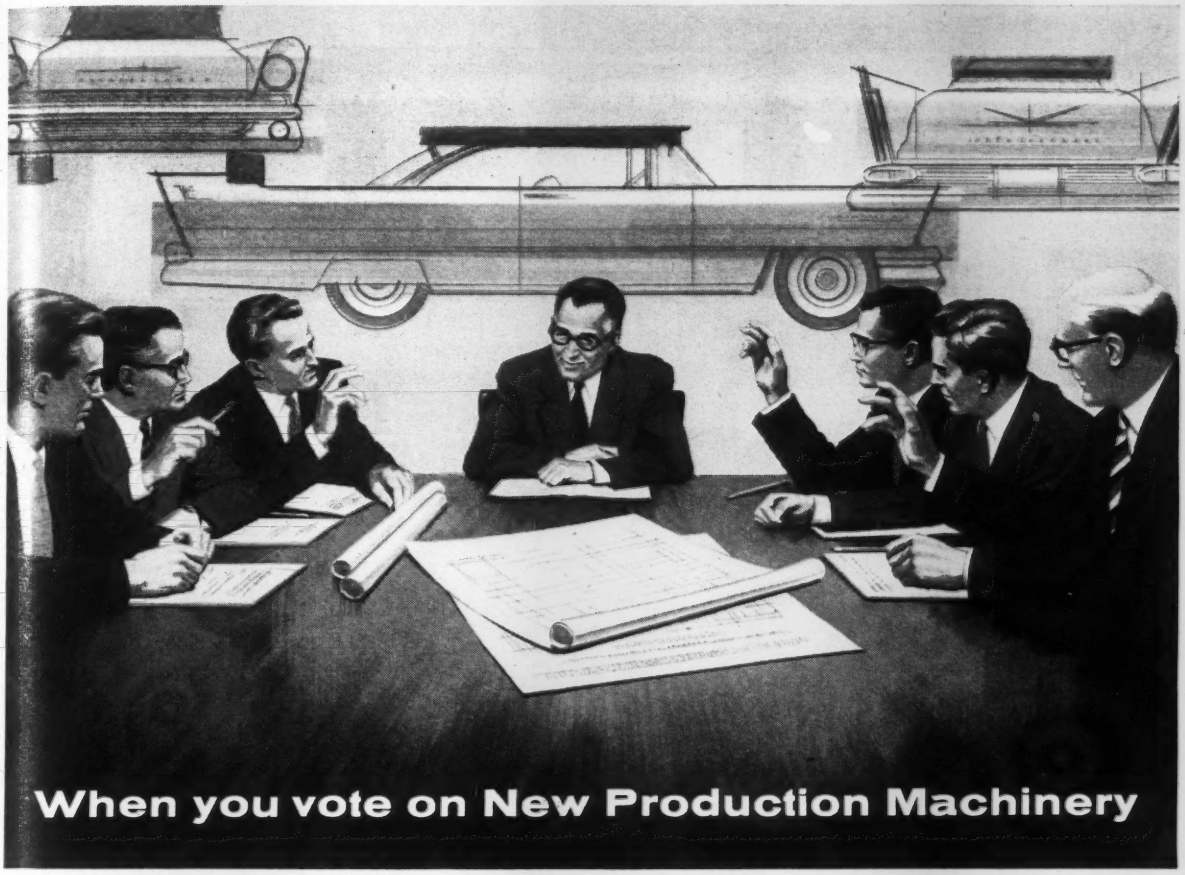
You'll come to electronic control sooner or later. Why not look into the Swartwout Autronic System of electronic control *now*? A card, wire or call will bring a qualified representative. AA-3609

Swartwout Autronic® Process Control Equipment

Roof Ventilators and Ventilating Louvers

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

For more information circle **65** on inquiry card.



...do you vote a straight AMERICAN ticket?

There's no real substitute for American-made production machinery in any branch of American industry. Designed and built to take the strains and stresses of the world's toughest demands for speed and endurance . . . with a minimum of down-time and maintenance . . . American machines are today more than ever the best buy in every field from textiles to metal-working. Yes, American production machines are the backbone of America's competitive economy . . . *and why settle for anything else?*

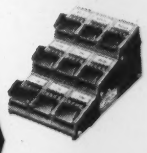
VEEDER-ROOT INC.

"The Name that Counts"

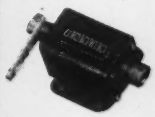
Hartford, Conn. • Greenville, S. C. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

. . . and here's why it pays to make sure that All New Machines you buy are equipped with NEW VEEDER-ROOT COUNTERS...

Modern Veeder-Root Counters are available for *building into* . . . or attaching onto . . . all types of production machines. They are built with unmatched Veeder-Root know-how and quality for years of accurate *Countrol* of production and uniformity. Ask your Industrial Supply Distributor or write Veeder-Root Inc., Hartford 2, Conn.

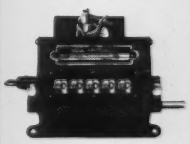


Hand Counting: Vary-Tally Multiple Unit Reset Counters for inventory, inspection and 1,001 hand-counting jobs. Up to 108 counters in 1 bank.



Mechanical Counting: Small resets count strokes, turns, pieces . . . are built into machine tools, light presses, etc.

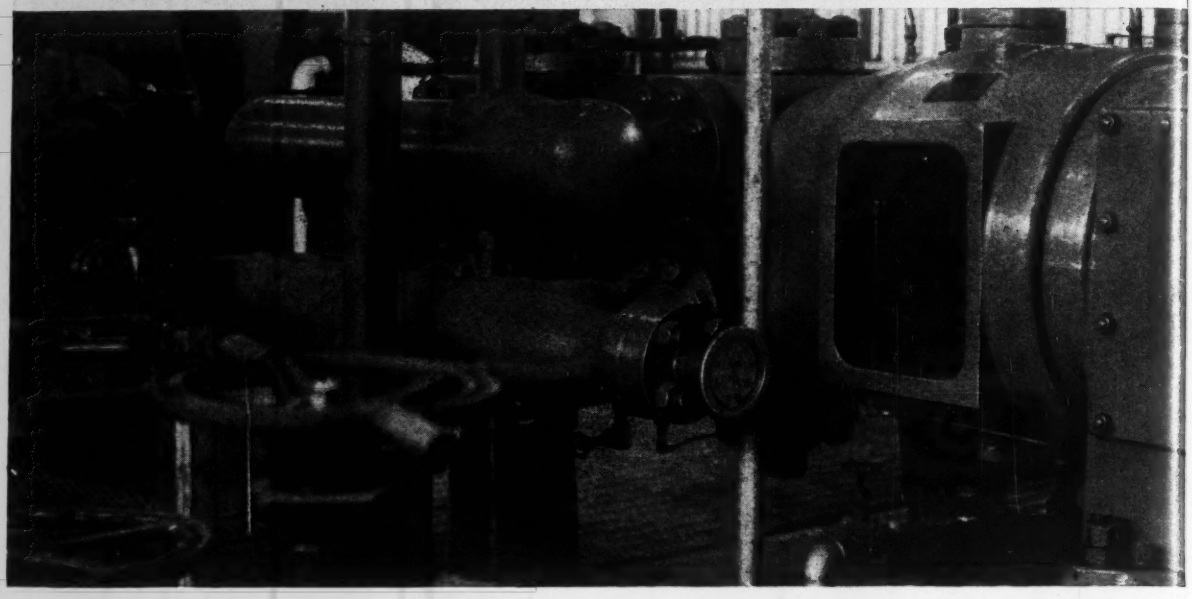
Electrical Counting: Remote indicating counters (AC or DC) bring your production machines as close as your office wall. May be panel-mounted in groups.



Controlling: Set for number of turns, pieces or operations required. Predetermining Counters control the run exactly . . . prevent over-runs and shortages.

For more information circle **66** on inquiry card.

VIBRATION

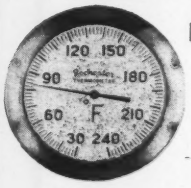


Vibration of refinery compressor proves unshakable accuracy of RMC thermometer

The RMC Thermometer shown in the photograph is constantly subjected to extreme vibration from the two-stage Synthesis Gas Compressor on which it is installed. This powerful equipment is used to compress a mixture of H_2 and N_2 from 400 to 3500 pounds—at the Philadelphia Synthetic Ammonia Plant of The Atlantic Refining Company.

This particular job required a special thermometer that could withstand the constant and terrific vibration, and at the same time provide and maintain precise, accurate readings. Rochester Manufacturing Company promptly came up with the answer—a silicone-dampened, bimetallic, angle-form RMC thermometer. And this is but one example of how RMC engineering skill provides instruments that meet the most demanding and exacting requirements.

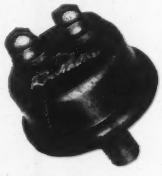
Look to RMC for Full-Line Instrumentation



DIAL THERMOMETERS

Illustrated here is a 6" dial thermometer with hermetically sealed dial chamber, external recalibration—built for heavy duty service. What are your thermometer requirements?

PRESSURE SWITCHES



This RMC Pressure Switch will stand heavy pulsating pressures, has close on-off differentials, maintains consistent cut-in, cut-out settings. What are your pressure switch problems?

TELL US YOUR REQUIREMENTS FOR DIRECT MOUNTING AND REMOTE INDICATING INSTRUMENTS, AND LET RMC ENGINEERING SKILL PROVIDE THE ANSWERS!

REPRESENTATIVES IN ALL PRINCIPAL CITIES

RMC

"You Can Rely On Rochester"

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

© 1956 Rochester Manufacturing Co., Inc.

ROCHESTER MANUFACTURING CO., INC.
139 ROCKWOOD STREET • ROCHESTER 10, N.Y.

For more information circle **67** on inquiry card.

ENGINEERS-SCIENTISTS: ANNOUNCING A VAST PROGRAM IN MISSILES RESEARCH AND DEVELOPMENT IN PHILADELPHIA WITH MANY ATTRACTIVE PROFESSIONAL OPPORTUNITIES

The Missile & Ordnance Systems Department of General Electric

Where We Are...

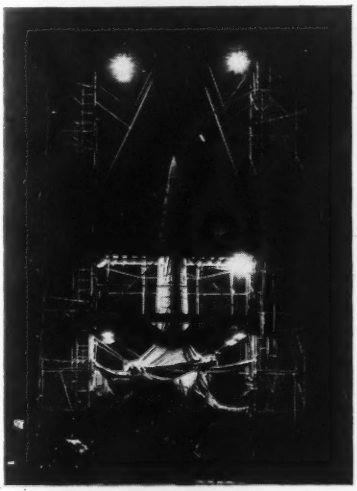
In PHILADELPHIA near 30th St. PRR Station...until our new 110 acre facilities are ready in Valley Forge—17 miles by Schuylkill Expressway from Downtown Philadelphia.

What We're Doing...

A PRIME CONTRACTOR—developing the ICBM and IRBM Nose Cones complete with nuclear arming and fuzing devices, gyros, accelerometers, resolvers, induction generators, amplifiers, servos. This G-E Department is the center of company-wide studies in viscosity, diffusion, thermal conductivity, radiation, laminar and turbulent shock layers, etc., for a vast missile system program.

How We're Doing It...

The Department's primary objective is to create the country's TOP TEAM on Guided Missile Research and Development and with this team assume FULL MISSILE SYSTEM RESPONSIBILITY for the entire General Electric Company. This will involve making use of the tremendous potential in the company's more than 100 operating departments and its many research laboratories.



ZERO minus 4 hours! A G-E test missile, still shrouded in the early morning dampness before launching, represents more than a decade of research and development.

Where We're Headed...

INTO EVERY PHASE OF MISSILE RESEARCH & DEVELOPMENT including:

...MISSILE WEAPONS SYSTEMS—target and missile tracking—radars—computers—handling equipment—launching equipment—logistics equipment—and others, all designed FROM THE GROUND UP as one system!

...SPECIFIC MISSILES—also Satellites including propulsion, guidance, airframes, and warhead arming and fuzing devices.

...SPECIAL COMPONENTS OF MISSILES—such as inertial guidance systems.

What We're Using...

HYPERSONIC WIND, SHOCK, HELIUM TUNNELS—mass accelerators—linear accelerators—electric arc mass accelerators—hyper-velocity shock tunnels. UNDER DEVELOPMENT: the LARGEST GAS SHOCK TUNNEL in the country...PLUS laboratories and equipment second to none. AND WHEN NEEDED—the resources of over 100 other G-E departments!

What All This Means to You...

Stable career growth, full use of your abilities, creative experience and rapid advancement either into management or further specialization, with a profesional staff that is expanding rapidly.

Scientists with advanced degrees will have a particularly attractive opportunity to engage in high levels of basic and applied research in such advanced fields as Astrophysics, High Temperature Phenomena, Advanced Mathematical Concepts, Aerodynamics, Classical Physics, Materials Development, and Communications Theory.

...Engineers and Scientists with education and experience in any of the fields listed below are invited to correspond with us...

DEGREE: *Electrical Engineer, Aeronautical Engineer, Aerodynamics, Mechanical Engineer, Physics, Mathematics.*

EXPERIENCE: SYSTEMS—*Development, Synthesis, Operations Analysis* • AEROPHYSICS • COMPUTER DESIGN—*Analogue, Digital* • MATERIALS & PROCESSES • INSTRUMENTATION—*Telemetry, Transducers, Recording, Recovery* • DATA PROCESSING—*Systems Design, Analysis, Programming* • GUIDANCE—*Intertial Guidance, Component Development* • TECHNICAL WRITING • FIRE CONTROL • STRUCTURES—*Thermodynamics, Electrical Design, Stress Analysis, Structure Design, Vibration, Aerodynamics* • ARMING AND FUZING—*Component Development, Test Equipment* • FIELD TEST • SYSTEMS TEST • GROUND SUPPORT EQUIPMENT DESIGN—*Controls, Handling Equipment, Launching Equipment.*

Missile & Ordnance Systems Department would be pleased to receive a resume of your education and experience.

All resumes will be carefully reviewed by the MANAGERS of our varicus technical components. You will be invited to visit our offices and discuss the work we are doing directly with the manager with whom you would be working. All communications will be entirely confidential. (You need not reveal the name of your present employer.)

Please send resume to Mr. John Watt, Room 510-5

MISSILE & ORDNANCE SYSTEMS DEPARTMENT

GENERAL ELECTRIC

3198 Chestnut Street • Philadelphia, Pennsylvania

INSTRUMENTS and AUTOMATION

New Instruments

CONTENTS OF THIS DEPARTMENT

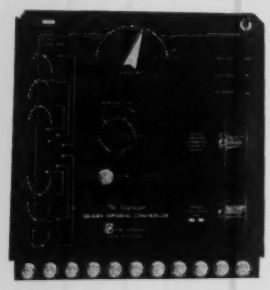
For Aircraft and Missiles	2296	Electronic Instruments	2279	Pressure	2257
Computing	2268	Flow Rate	2262	Process Measurement and Control	2252
Connectors	2291	Force	2264	Relays	2289
Counting	2267	Inspection	2275	Shop Equipment and Supplies	2273
Data Processing	2268	Laboratory Equipment	2271	Speed	2265
Electrical Components	2285	Mechanical Components	2292	Switches	2290
Electrical Instruments	2279	Mechanical Testing	2276	Temperature	2258
Electrical Testing	2277	Miscellaneous	2299	Time	2266
Electromechanical Components	2288	Nucleonics	2272	Valves	2293
Electronic Components	2287	Photography	2270		
		Power Supplies	2283		

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 2327

PROCESS MEASUREMENT and CONTROL

PROCESS CONTROLLER USING OPTIMAL MODE

New "Optimal Controller" is said to be the first embodiment of principle of optimally controlling a process by analyzing process output following a

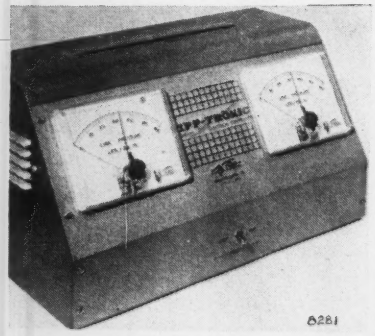


step change imposed at input. It analyzes output after preset time delay; (one model has delays of 0 to 30 min; another, 0 to 5 hr). Change can be imposed at high or low points, or at any desired slope of process reaction curve. Slopes of 0 to 2½ can be accommodated when maximum change is 10% of total. Instrument accepts all standard pneumatic or electrical input signals.—*Quarie Controllers, Canton, Mass.*

For more information circle **201** on inquiry card.

PROCESS CONTROLLERS

New "Tipp-Tronic Industrial Controls" provide monitoring and automatic control of properties or conditions that can be measured electrically. Sensitivities begin with 0 to 5 micro-amperes or 0 to 5 milivolts. Units normally operate on dc; can be adapted easily to ac in most cases; are calibrated in applicable units, with



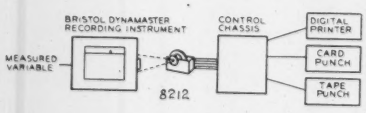
8281

one indicating pointer and a set-point index. Control accuracy is said to be within 2% of settings. Multiple models are available. Photo shows a duplex controller.—*Tipp Mfg. Co., Tipp City, Ohio.*

For more information circle **202** on inquiry card.

RECORDING POTENTIOMETERS FOR DIGITAL READOUT

New "Dynamaster" high-speed self-balancing recording potentiometers and bridges for use with analog-to-

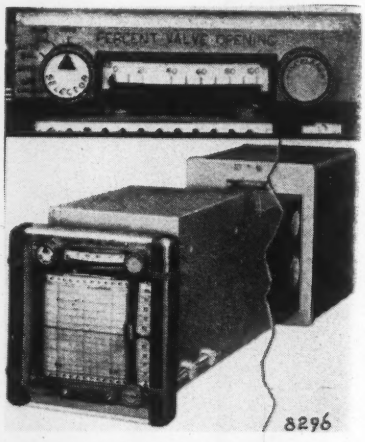


digital conversion devices are designed to give full-scale traverse in 0.4 sec; make available ample torque for operating retransmitting slidewires, alarm contacts, and other auxiliary devices without affecting dynamic characteristics. Round chart models are also available. Various pen speeds.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **203** on inquiry card.

PROCESS CONTROLLERS and RECORDER-CONTROLLERS

New "Unitized Autronic Controls" embody maker's "Autronic" method of instantaneous all-electronic control.

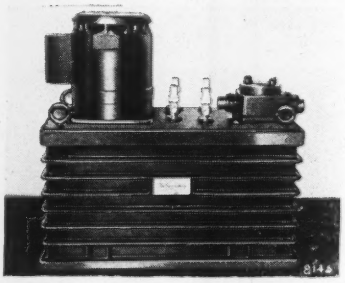


"Unitizing" is said to result in a number of advantages, among them: controller, recorder (or indicator) and manual control of plug-in construction; any combination of units within a universal case; wiring between individual instruments eliminated; instruments can be easily pulled out of panel do without employing "jumpers" and without upsetting system balance. —*The Swartwout Co.*, 18511 *Euclid Ave., Cleveland 12, Ohio.*

For more information circle **204** on inquiry card.

ELECTRONIC-HYDRAULIC CONTROL SYSTEM

New "Swisstrol" is claimed to eliminate problems of lag and hunting. All assemblies are custom-designed but

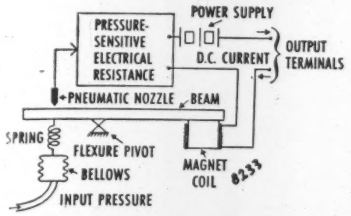


are "basically identical." Electronic components comprise specially-wound coils and two electron tubes, one of which serves as stand-by. Only moving part inside 21"x11"x21" cast-iron case is a small 4-way hydraulic valve. Motor-driven hydraulic pump is mounted on top cover of case which serves also as an oil reservoir, all equipment being oil-submerged. Wherever possible, master element (e.g. Bourdon tube) is mounted inside case; otherwise (as in level control) connection is electrical. Guaranteed for 30,000 hr of operation.—*The Swiss Colony, Monroe, Wis.*

For more information circle **205** on inquiry card.

CONTROL SYSTEM WITHOUT TRANSMISSION LAG

New "P-E-P" electromechanical control system converts pneumatic signals into direct current for long-range

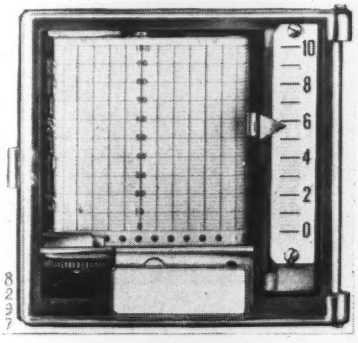


transmission and then reconverts to pneumatic pressure for actuating control valves or other pneumatic equipment. It permits extremely low cost remote measurement, indication, recording and controlling of process variables by elimination of electronics and complex circuitry. Transmitter unit is said to utilize "the best advantages of both electrical and pneumatic control systems."—*Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. 4th St., Philadelphia 33, Pa.*

For more information circle **206** on inquiry card.

MINIATURE POTENTIOMETER

New model of maker's "Dynamaster" self-balancing electronic potentiometer (or bridge) in 5" square case



records on a 3" strip-chart; uses standard components; is identical in appearance to maker's "Metagraphic" pneumatic recorder. Accuracy and sensitivity are unchanged from standard 12" instrument. Instruments are furnished in indicating models also. Indicating and recording chassis are both built for full plug-in service; can be interchanged with each other in seconds; can be used to measure and indicate or record any variable which can be converted into an electrical measurable.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **207** on inquiry card.

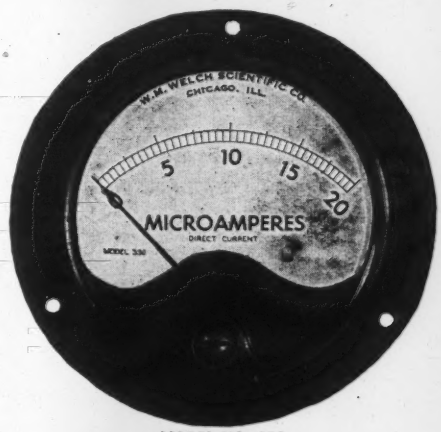
PROCESS SHUTOFF & ALARM

New "Impulse Monitor," said to be "the first safety shutoff and alarm for automatically controlled processes which requires no sensing elements or electronic circuitry," safely shuts down process and sounds an alarm

Expertly Designed - Highly Sensitive - Sturdily Built

D. C. PANEL METERS

SENSITIVE **20** MICROAMPERES MOVEMENT

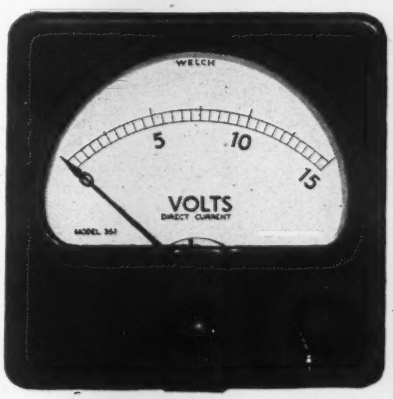


MODEL NO. 350

• Accuracy 2% of full scale deflection

Welch Model 350 Panel Meters are often used in temporary "bread-board" assemblies and in "homemade" devices so common in electronics laboratories. In such work it is frequently more convenient to have an attached rather than a separate meter.

Suitable for such applications as measuring grid currents and currents from photoelectric tubes and cells. They have alnico magnets, sapphire bearings, and especially selected pivots to make possible the extremely sensitive 20 microampere movement.



MODEL NO. 351

These precision instruments are expertly designed, highly sensitive, sturdily built and adapted for work requiring the most rugged performance.

- Stable and Well-Damped
- Flush Mounting Bakelite Cases
- High Torque Ratio

MODELS

350—3½ inch round—2.4 inch scale
351—3 inch square—2.4 inch scale
451—4½ inch rectangular—3.5 inch scale

MODEL NO. 451

TYPES

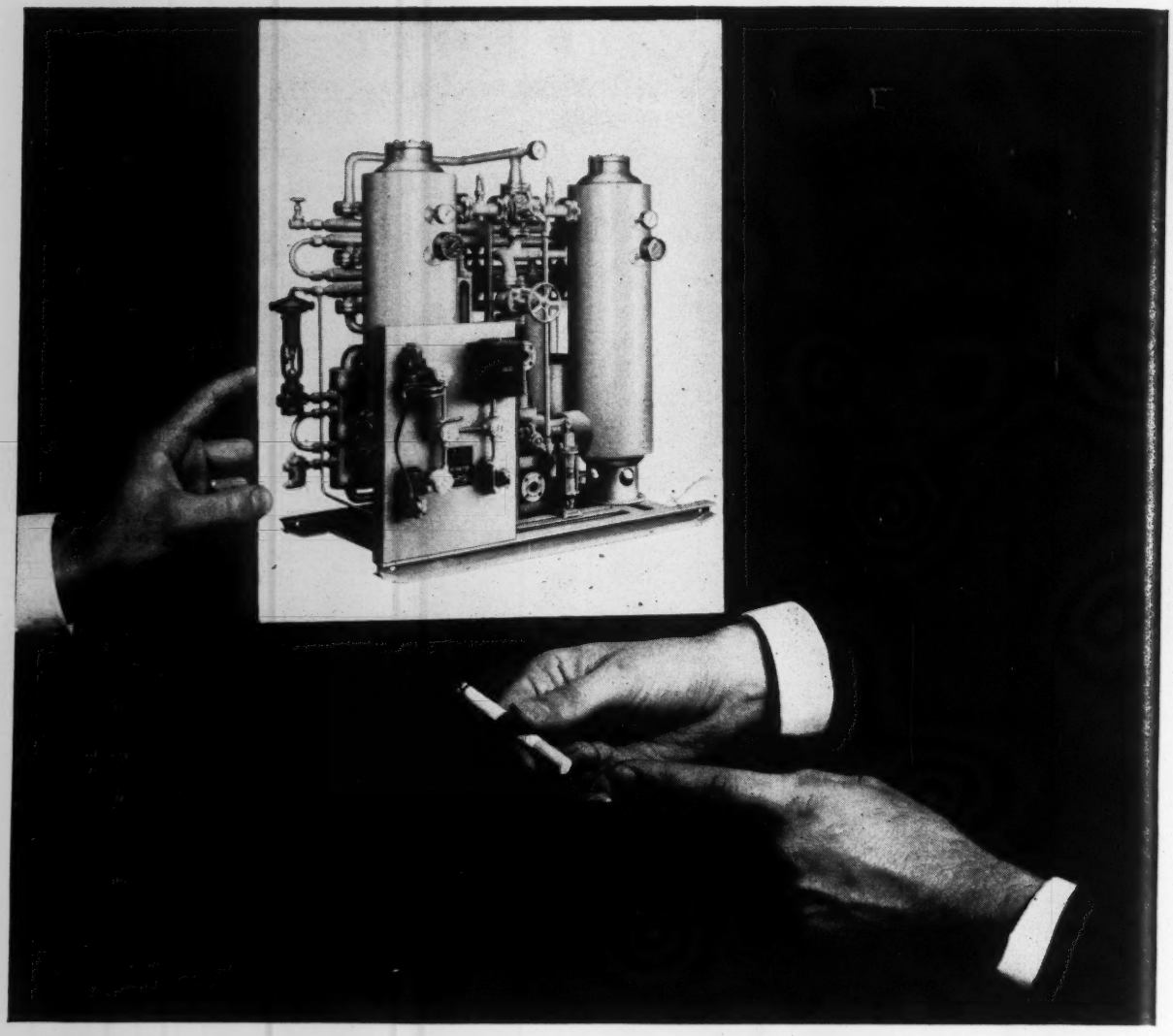
Microammeters 0-20 up to 0-500
Milliammeters 0-1 up to 0-500
Ammeters 0-1 up to 0-30
Voltmeters, various ranges, 100 to 50,000 ohms per volt
Zero Center Ammeters
DB Meters
Rectifier Instruments
Thermocouple Meters
Special Scaled Meters

A complete line of round, square, and rectangular meters is manufactured by Welch.

WRITE FOR OUR METER CATALOG

W. M. WELCH SCIENTIFIC COMPANY
DIVISION OF W. M. WELCH MANUFACTURING COMPANY
ESTABLISHED 1880
1515 Sedgwick Street, Dept. B Chicago 10, Illinois, U. S. A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **69** on inquiry card.



"How can you compare a Pritchard Hydryer with a filter on a cigarette?"

"You know how a cigarette filter removes unwanted materials in your smoke? Well, the Pritchard Hydryer removes or 'grabs' the moisture in the air we use to operate our instruments."

"Is this 'grabbing' action the same in both?"

"Not exactly. You see the 'grabbing' action, as you call it, in the Hydryer is accomplished by an adsorption process in which solid adsorbents are used to reduce the moisture content of the instrument air stream. In a cigarette, the filtering is purely a mechanical action."

"Why are we so interested in dry air for our instruments?"

"First, because our precision instruments must have exceptionally dry air to operate accurately, and second, because moisture in our air lines can cause corrosion and freeze-ups in cold weather."

"How about the capacity of our Hydryer?"

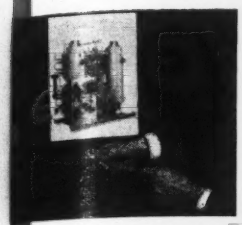
"Right now we're getting air delivered continuously with a dew point temperature not in excess of —20°F.; capacity, 420 CFM at standard conditions; pressure 100 psig; temperature, 80°F."

"No more frozen or corroded air lines for us then!"

"Not with our Pritchard Hydryer."

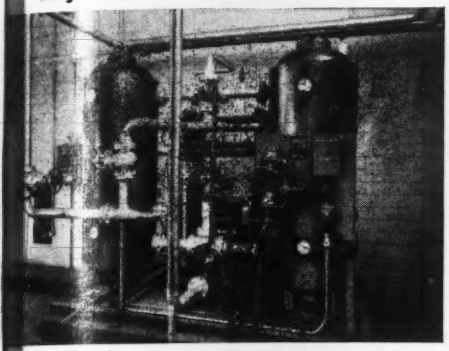
J. F. PRITCHARD & CO. OF CALIFORNIA
4625 Roanoke Parkway, Kansas City 12, Mo.

For more information circle **70** on inquiry card.



"How can you compare a Pritchard Hydryer with a filter on a cigarette?"

The Pritchard HYDRYER®
Unmatched for Continuous Delivery of Dry Instrument Air!



Precision automation instruments demand a constant source of extremely dry air for accurate operation. The Pritchard HYDRYER has proved its ability to deliver air that is free from damaging moisture. Only in a Pritchard HYDRYER do you get all of these features:

- NO WASTE—100% of all air or gas entering the HYDRYER is dried without loss.
- FULL LINE PRESSURE REACTIVATION — Pressuring and depressuring of adsorbers between cycles is eliminated.
- PURGING ELIMINATED — The Type A HYDRYER uses inlet main air streaming for reactivation.
- LONGER ADSORBENT LIFE.
- REACTIVATED GAS PRE-HEATED
- NO MOVING PARTS
- SIMPLIFIED OPERATION
- REDUCED EQUIPMENT AND LINE SIZES

. . . plus many more advantages.

SEND FOR BULLETIN

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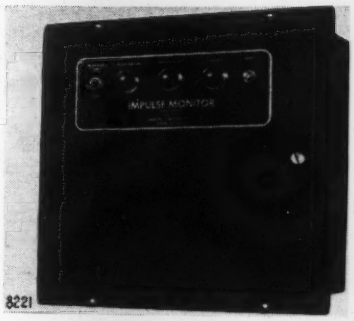
For more information circle **70** on inquiry card.

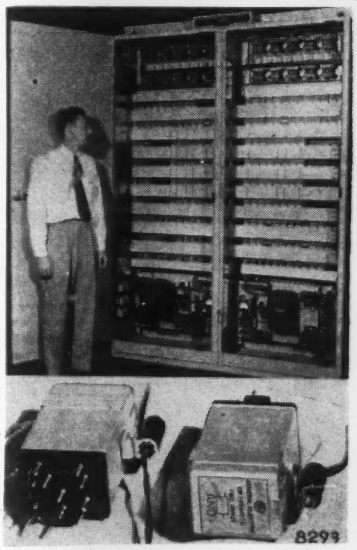


in event of controller failure in "on" period; sounds alarm in event of abnormal "off" period or fusing of power contactor. Present models are designed primarily for heat treating furnaces, but principle can be applied to any process involving heat, pressure or flow where control system uses an on-off, two-position or pulsing mode of control mode and where input is reasonably uniform duration. —*Damol Corp.*, 541 *Land Title Bldg., Philadelphia* 10, *Pa.*

For more information circle **208** on inquiry card.

STATIC SWITCHING CONTROL

New static switching control system, with many advantages over systems depending on contact-making



devices, makes available a complete line of static components to provide the five logic functions basic to intelligence switching (AND, OR, NOT, MEMORY, and TIME DELAY), also power supplies, output amplifiers, etc.; can be furnished in completely engineered panels and systems (upper photo) or in component form (example: AND unit in lower photo). New system can be combined with available regulating systems of static type, to make possible a co-ordinated overall static system. Reliability and freedom from malfunction: (1) fail-safe circuitry, (2) on return of power after any power removal, circuit re-

Telemeter
ANY VARIABLE from Remote Points!

Accurate HIGH-SPEED Continuous
for POWER PRESSURE HUMIDITY POSITION VOLTS SPEED, ETC.

Telemeter transmitter converts DC mv from thermal converters, etc. to 10-30 cps which frequency modulates an audio tone channel. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed. Any communication link, including power line carrier, may be used. Overall accuracy is 1% with a response speed of 1 sec.

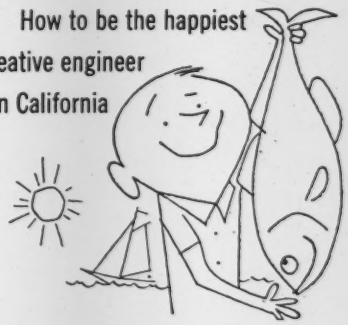
Other terminals for teletype, voice-plus-control & data transmission are available.

Write for Technical and Application Data.

Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **120** on inquiry card.

How to be the happiest creative engineer in California



Beckman Instruments, Inc.* offers E.E.'s, M.E.'s, Manufacturing, and Sales Engineers the kinds of jobs that creative men dream about. Top salary, all employment "extras" including our Educational Assistance Plan, modern facilities and personal recognition that comes naturally with our decentralized operation. Small town living...but near metropolitan areas in either Fullerton, Newport Beach, Richmond, or Palo Alto.

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sumes operation at same point in cycle where it left off. Among features: encapsulation, plug-in construction, packaged power supplies, built-in wire trough, monitor lights.—*General Electric Co., Schnectady 5, N. Y.*

For more information circle **209** on inquiry card.

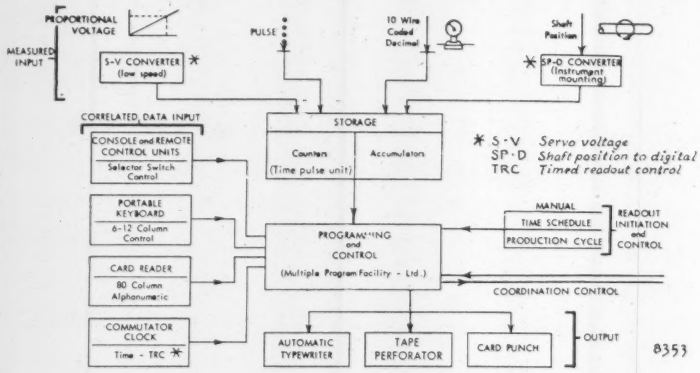
VISUAL AND AUDIBLE ALARM

New "Larm-Tector Model 50" is a remote visual and audible alarm for use in connection with low-water cut-outs, flame failure systems, smoke controls, etc. By automatically reseting itself after each operation, it insures that alarm will be sounded on next "unsafe" indication. When such occurs, red light comes on first; then, after a delay of 30 sec, buzzer sounds. Silencing pushbutton can be pressed at any time after the red light is energized to de-energize audible alarm only. Time delay switch is adjustable from no-delay to 2 min. As an added safety feature, "Larm-Tector" cannot be permanently disconnected from circuit by an operator or attendant.—*Way-Wolff Associates, 33 Fulton St., New York 38, N. Y.*

For more information circle **210** on inquiry card.

8289

AUTOMATIC PROCESS AND PRODUCTION RECORDING SYSTEM



New "APR" fully-integrated system collects, correlates, stores and records process and production data in punched tape and cards and prints out reports on automatic typewriters. Card and tape media, containing data on temperature, weight, count, etc., together with related information identifying product and process, are used as input to accounting machines. Flexibility: sixteen newly-developed "building-blocks" are assembled in appropriate combinations to meet user's requirements. Measurements made by commercially-available instruments are read electrically and, if necessary, are digitized. An on-demand or time-programmed read-out can be initiated at any stage for visual display of data being accumulated in storage. Non-variable identifying data, such as machine number, can be introduced into system from rotary switches on console or remote control panels, by portable keyboards, or by card readers which read data from IBM pre-

ADJUST-ANGLE THERMOMETERS
for every conceivable use

Solve your temperature indication problems with one of Weksler's easy-to-read ADJUST-ANGLE thermometers. Available in three case styles and in scale sizes from 4½ to 12 inches, these versatile instruments position any angle through 180° arc, back or front, right or left; even after installation!

Sturdily built to withstand vibration, shock and strain, even under the most rugged conditions, ADJUST-ANGLE solves intricate instrumentation problems by affording installation flexibility and maximum visibility.

Ask your jobber TODAY for complete technical information, or write to:

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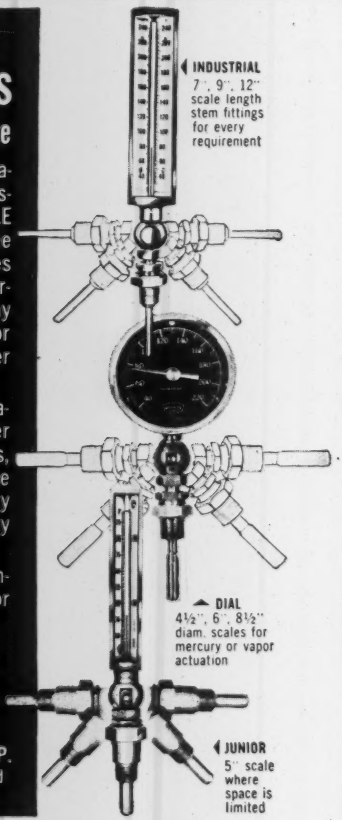
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7", 9", 12" scale length stem fittings for every requirement
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JUNIOR
5" scale where space is limited

For more information circle **71** on inquiry card.

Controls Engineers are Key Men

at the Small Aircraft Engine Dept. of General Electric.

A most important element of engine design is harnessing the power to bring the aircraft home safely. This puts a Controls Engineer in a key spot.

Now unique opportunities exist for talented men to develop controls for new product line of advanced small turboshaft, turboprop and turbojet engines.

In ENGINE CONTROLS DEVELOPMENT

SYSTEMS DESIGN: responsibility to design and develop advanced systems—performance requirements—schematic diagrams—component and test specifications.

COMPONENT DESIGN: design, develop and package specific controls components (sensors, actuators, fuel flow components, etc.)

EVALUATION: determine controls test facilities. Direct component and systems testing. Correlate test data. Evaluate test results. Make recommendations to design groups.

ANALYSIS: determine engine controls parameters. Prepare systems. Block diagrams. Analyze controls stability. Provide performance specifications, (systems and components).

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PARTS MARKING

includes stamping, printing and many other processes. All are available at ACROMARK—to the extent of their practical use for product marking.

Several different types of standard and special machines for hot or cold process marking can among them provide the answer to your perfect product marking.

Send a sample or drawing of your product for our engineer's recommendation at no obligation.

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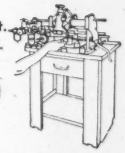

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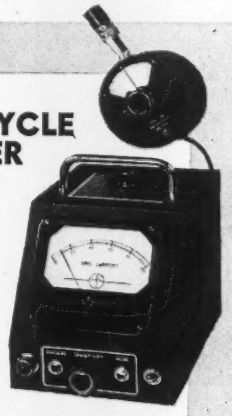
For more information circle **122** on inquiry card.

MEGACYCLE METER



For determining the resonant frequency of tuned circuits, antennas, transmission lines, by-pass condensers, chokes, etc. For measuring inductance and capacitance. May also be used as an auxiliary signal generator, and in many other applications.

Available in the following frequency ranges:

Model 59-LF	0.1 to 4.5 Mc
Model 59	2.2 to 420 Mc
Model 59-UHF	420 to 940 Mc

Laboratory Standards

MEASUREMENTS CORPORATION

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For more information circle **127** on inquiry card.

punched cards.—*International Business Machines Corp., 590 Madison Ave., New York 22, N. Y.*

For more information circle **211** on inquiry card.

PRESSURE

PRESSURE GAGES

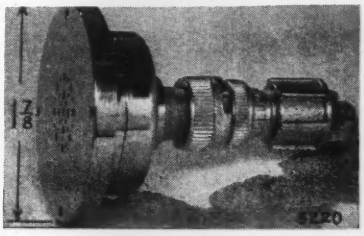
New "Bandrive" pressure gages incorporate a new concept in transmitting linear motion: Deflection of

Bourdon tube or pressure cell is transmitted to pointer without gears. New movement eliminates usual gear rack, pinion gear, and hairspring assembly; it utilizes long-deflection constant-force spring. Motion of sector is transmitted to pinion through this band, eliminate backlash and lag between prime mover and pointer. Constancy of torque upon entire system minimizes effects of linkage fits and other play. Constant-force spring is self-restoring, eliminating hairspring. "Bandrive" pressure gages are made to ASME standards are interchangeable with older types.—*Norden-Ketay Corp., 99 Park Ave., New York 16, N. Y.*

For more information circle **212** on inquiry card.

DYNAMIC PRESSURE PICKUP

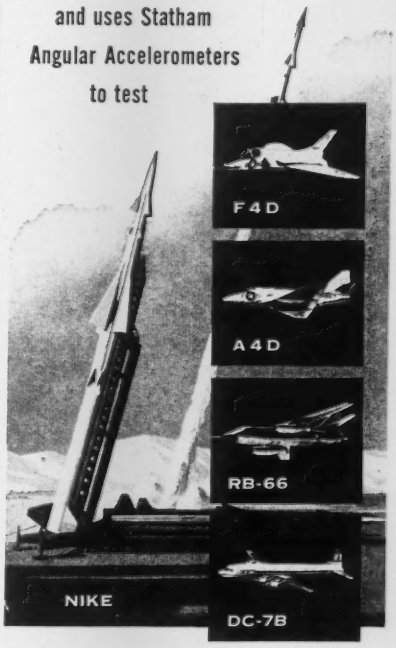
New "Type 4-340 Dynamic Pressure Pickup" utilizes electrokinetic ("streaming-potential") effect to measure rapid pressure changes, such as complex waves from sonic vibrations, blast pressures, and water hammer in liquid-filled lines. A pressure change causes an infinitesimal amount of a polar liquid to flow into and out of the opposite faces of a porous partition, whence a potential difference. New pickup's operating pressure range is 10^{-4} to 100 psig; temperature range −10°F to 140°F. Response is flat between 3 cps and



Do you think about Angular Acceleration?

DOUGLAS does...

and uses Statham Angular Accelerometers to test



Statham unbonded strain gage liquid rotor angular accelerometers offer a simple, reliable means for the study of the rotary motion of a test body under conditions where a fixed mechanical reference is not available. For static and dynamic measurements in ranges from ±1.5 to ±3,000 rad/sec², four standard models are offered.

Please request Bulletin AA2

Statham LABORATORIES LOS ANGELES 64, CALIFORNIA

For more information circle **73** on inquiy card.

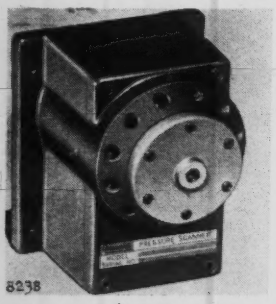
NEW INSTRUMENTS

2500 cps. No phase lag or overshoot. Extraordinary stability: pickup retains its calibration after temperature cycles, pressure cycles, shock and vibration. Internal impedance (100,000 ohms) is much lower than that of piezoelectric pickups used in similar work. Exceptionally high output: about 35 v (open circuit) for a 100-psig oscillation. Many types of electrical and electronic instruments can be used.—*Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*

For more information circle **213** on inquiry card.

PRESSURE SCANNER

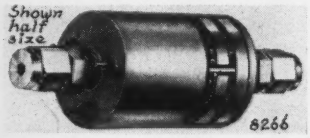
New "Model SP-101 Pressure Scanner" enables measurement of up to twelve pressure sources with only one primary measuring element; can be used (1) to increase accuracy of measurement with presently available components and (2) to automatically introduce calibration and/or zero pressures during each scan cycle, permitting calculation of exact primary-element response; is vented to atmosphere between pressure ports, eliminating pickup hysteresis effects. Basically, it consists of (1) stator having 12 input ports, and (2) rotor that connects any input port to an output port and is rotated to a desired position by (3) unidirectional high-torque motor whose operation is controlled by means of a positive positioning arrangement. Range 0.1 psia to 350 psig.—*Datex Div., G. M. Giannini & Co., Inc., 1307 S. Myrtle Ave., Monrovia, Calif.*



For more information circle **214** on inquiry card.

PRESSURE PICKUPS

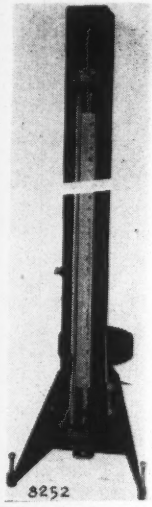
New "Series Z" pickups cover a number of ranges and applications requiring measurement of gage, differential and absolute pressures for noncorrosive (and some corrosive) media, at temperatures up to 350°F—*Rahm Instruments, Inc., 237 Lafayette St., New York 12, N. Y.*



For more information circle **215** on inquiry card.

EIGHT-SCALE MANOMETER

New "8-Scale Instrument Test Manometer" has 61" scale length (other scale lengths special). Scales are mounted on an 8-sided vertical drum, permitting any scale to be easily rotated into reading position. Scale calibrations are in any desired units. Scale drum can be adjusted vertically through 3" to compensate for changes in barometric pressure. Wall mounting brackets optional.—*King Engineering Corp., Box 640, Ann Arbor, Mich.*



For more information circle **216** on inquiry card

TEMPERATURE

MULTI-POINT MULTI-RANGE THERMISTOR THERMOMETER

New six-channel, five-range "Model 46" is added to maker's line of "Tele-Thermometer" thermistor thermometers; covers 30°F to 110°F with

Save Space and Weight

with

BRIDGEPORT

¼" diameter bellows

Bridgeport seamless metal bellows of ¼" and 5/16" diameter now permit additional miniaturization in aircraft, instrumentation, and other equipment. At the same time, they provide excellent sensitivity to pressure or temperature changes. Available in many metals with many characteristics. Larger sizes also available.

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☐ Send data on small-diameter bellows

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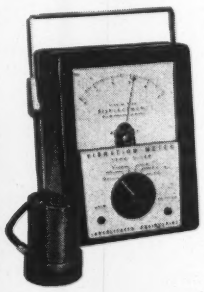
For more information circle **74** on inquiry card.

measure vibration anywhere

CEC's 1-128 vibration meter



Here's new ease in tracking down and measuring mechanical vibration . . . CEC's new 1-128 *all-transistor* Vibration Meter. It contains its own power source, can be operated anywhere. Using standard CEC self-generating pickups, the meter indicates vibration *directly* as mils peak-to-peak displacement.

Frequency range . . . 10 to 1000 cps
Sensitivity . . 0.0005" peak-to-peak displacement provides full-scale indication from 50 to 1000 cycles.
Temperature range . . . −20°F to +120°F
Power source . . . two standard 22½-volt batteries
Size and weight . . . 7½ x 5½ x 3⅜"; 7½ lbs., with batteries

For complete information, send today for Bulletin CEC 1566-X20.

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For more information circle **75** on inquiry card.

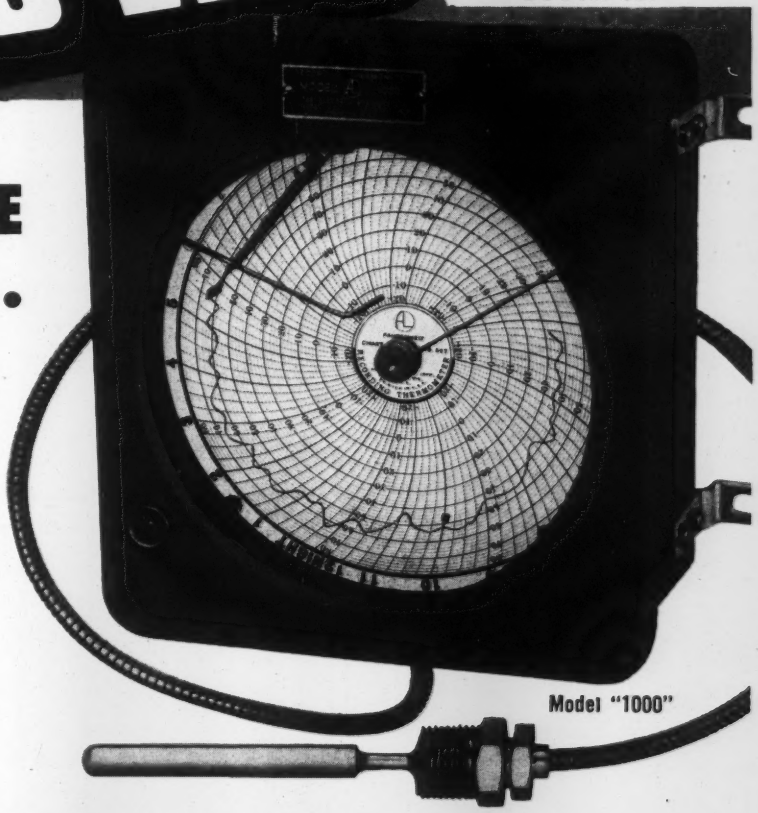
AUTO-LITE

AUTOMATION EXPOSITION
NOV. 26-30
BOOTH 326

TEMPERATURE RECORDERS...

Newly designed, Model "1000" Auto-Lite Recorder gives permanent proof of temperature behavior.

- 6″ clear reading chart; various standard ranges from minus 40°F. to plus 550°F.
- 3 standard types; choice of 24-hr. or 7-day cycle.
- Electric or mechanical chart drive.
- With capillary tubing for remote reading. Priced from $49.50



Model "1000"

TEMPERATURE INDICATORS...

Auto-Lite offers many thermometer styles, permitting plant-wide temperature observation at low cost. Standard temperature ranges from minus 60°F. to plus 750°F. Send for latest catalog showing various types of Auto-Lite Indicators and Recorders.

Model F-1 temperature indicator — Rigid stem or capillary tubing for EYE-LEVEL remote reading. Priced from $23.50

THE ELECTRIC AUTO-LITE COMPANY
INDUSTRIAL THERMOMETER DIVISION
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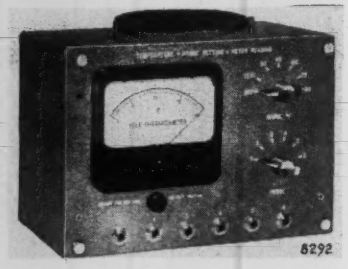
For more information circle **76** on inquiry card.

NEW INSTRUMENTS

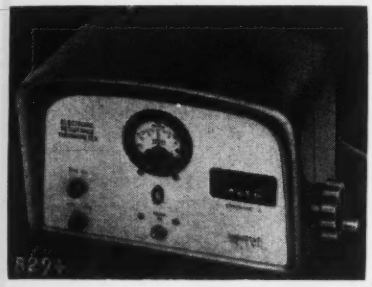


five 20 F° overlapping ranges; is accurate to 0.25 F° and readable to 0.1 F°. (Other ranges to order.) Any combination of maker's interchangeable thermistor probes can be used, remotely or locally.—*The Yellow Springs Instrument Co., Inc. P.O. Box 106 Yellow Springs, Ohio.*

For more information circle **217** on inquiry card.

RESISTANCE THERMOMETER

New platinum resistance thermometer, said to be "the first thermometer ever to cover a range from minus 100°C to 900°C, with 0.01 sensitivity and digital reading of temperature," obtains direct temperature reading by means of (1) a special circuit in Wheatstone bridge, whereby balancing resistor reading is made to follow a second-degree relation corresponding to temperature-resistance curve of platinum, and (2) a high-sensitivity electronic detector for rapid and precise balancing of bridge. To obtain extremely high accuracy (0.1 C° up to 400°C and 0.2 C° up to 900°C) each combination of resistance bulb and bridge is individually calibrated. Vac-

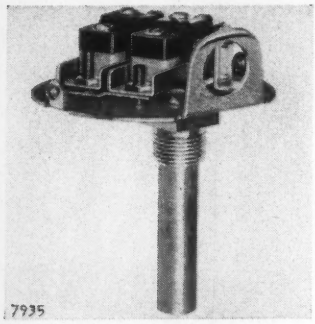


uum-sealed platinum elements and leads; hermetically sealed head; choice of stainless steel or quartz jacket. Also available: plug-in controller accessory with 0.05 C° reproducibility.—*Manostat Corp., 20-26 N. Moore St., New York 13, N. Y.*

For more information circle **218** on inquiry card.

TWO-SWITCH THERMOSTAT

New "Series 22000 Dual-control Thermoswitch" controls two independent circuits simultaneously; is available in three ranges: −75 to 125°F; 25 to 225°F; and 100 to 300°F. Each switch can be set in the field to actuate at any temperature within selected range. A differential setting arrange-

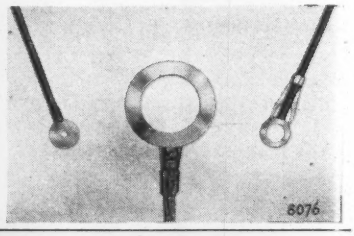


ment is also available, whereby second switch will actuate at a predetermined number of degrees above or below setting of first.—*Fenwal Incorporated, Ashland, Mass.*

For more information circle **219** on inquiry card.

MINIATURE GASKET TCs

New line of miniature gasket-type thermocouples includes a wider choice of gasket sizes, TC leads and lead



for an entirely new range of time delays

delay intervals:

1/10 to 5 seconds

recovery rate:

extremely rapid

Series H

specify sturdy, thoroughly field-tested

G-V HOT WIRE TIME DELAY RELAYS

Over two years of successful field service in electronic, aeronautical and industrial equipment prove these new G-V relays to be dependable, efficient and accurate.

- Adjustable Delay even though hermetically sealed
- DC or AC of any frequency for energization
- Small and Light. ¾" diameter, 2⅜" length. Weight: 1 oz.
- Wide Ambient Range compensated from −70°C to 100°C or higher
- Continuous Energization without damage
- Available in 7-pin Plug-in and Flanged designs

G-V Write for Pub. No. 35 — engineering data and drawings

G-V CONTROLS INC.

38 HOLLYWOOD PLAZA, EAST ORANGE, NEW JERSEY

For more information circle **77** on inquiry card.

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Before You Buy Precision Measuring Instruments

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Specialists in Dimensional Quality Control and Exclusive Representatives for

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For more information circle **78** on inquiry card.

Precision Temperature Control at Your Command

Klipfel GOLDEN GENIE

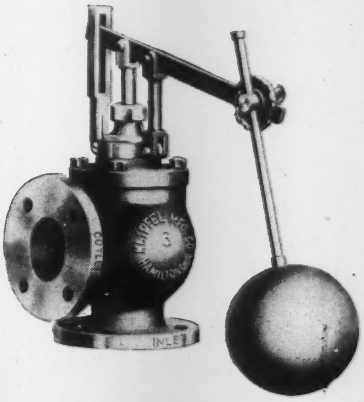
Self-Actuated Vapor Pressure TEMPERATURE REGULATOR

Modern design and skilled craftsmanship are combined in the new Klipfel Golden Genie to assure accurate, positive, low cost temperature control.

Featuring strong, long-lasting 2-ply bellows, it operates at higher working pressure with smaller bulb, develops more power for valve actuation.

Let Klipfel experience go to work for you. Write for full details on the new Golden Genie and the complete Klipfel line.

TO KEEP LIQUIDS on-the-level



Klipfel FLOAT VALVES

- Really automatic liquid level control . . . proven by a 40-year record of dependability in thousands of installations, large and small, water and chemical.
- Direct acting or pilot control types . . . single or double seated . . . for every possible requirement of pressure, temperature, fluid and closure.
- Also available with Klipfel's exclusive cup disc inner valve for tight control of liquids injurious to rubber and leather, and for higher pressures. Write for Bulletin 254.

Klipfel VALVES, INC.

Division of Hamilton-Thomas Corp.

Dept. D-11 Hamilton, Ohio

- **FLOAT VALVES • REDUCING VALVES**
- **TANK THERMOSTATS**
- **BACK PRESSURE VALVES**

Export Dept.—1010 Schaff Bldg., Philadelphia, Pa.

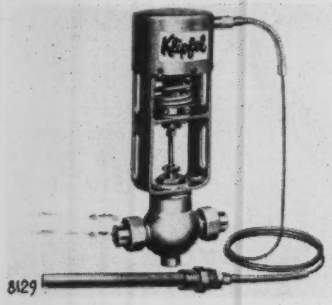
For more information circle **79** on inquiry card.

terminals. Designed originally for use beneath spark plugs, gasket TCs are now used extensively to measure skin temperatures in many industries.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

For more information circle **220** on inquiry card.

TEMPERATURE CONTROLLER

New "Golden Genie" self-actuated vapor-pressure-type temperature regulator features an extra powerful bel-

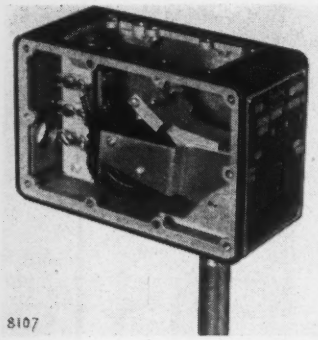


lows type of valve actuator which is protected against damage in event that bulb is subjected to over-range temperature. Tubular-design yoke, made of nodular iron, will not crack like cast iron, or deflect like a stamping.—*Klipfel Valves, Inc., Hamilton, Ohio.*

For more information circle **221** on inquiry card.

TEMPERATURE CONTROLLERS

New "Models F-1C, F-2C, and F-3C" differential-expansion-type temperature controllers feature choice

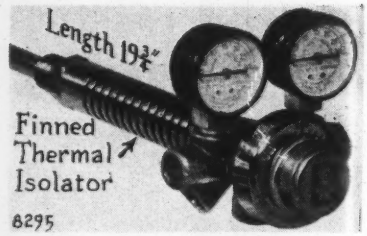


of one, two, or three snap-action switches on any instrument; adjustable ranges as wide as 1200°; weathertight cases. Choice of knob-and-pointer, or socket-head set-screw.—*Burling Instrument Co., 16 River Road, Chatham, N. J.*

For more information circle **222** on inquiry card.

TEMPERATURE CONTROLLERS

New "Model 1100C,D" of maker's "FulTrol" pilot type thermostatic controller is available in standard ranges of 250-450°F and 350-550°F; also in any 200° range between 50 and 600°F. Control differential field-adjustable between 5 F° and 25 F° with



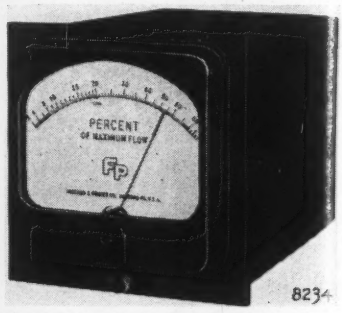
an ordinary screwdriver.—*Fulton Sylphon Div., Robertshaw-Fulton Controls, Box 400, Knoxville, Tenn.*

For more information circle **223** on inquiry card.

FLOW-RATE

FLOW-RATE INDICATOR

New "Industrial Logarithmic Panel Indicator" converts output signal of maker's turbine-type primary meter-



MARSHALLTOWN

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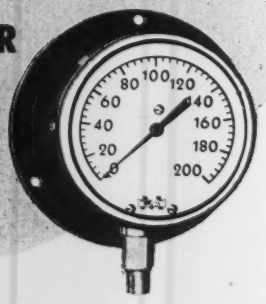

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- DIAPHRAGM
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- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

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MARSHALLTOWN MANUFACTURING CO.

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Marshalltown 3, Iowa

For more information circle **80** on inquiry card.

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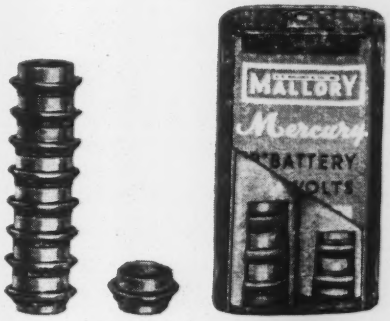
For more information circle **81** on inquiry card.

MALLORY

*Long-life Mallory Mercury Batteries are now available at economical cost in "B" battery voltages, thanks to unique "snap-together" cell design.**



Unique Cell Design Expands Economical Applications of Mallory Mercury Batteries

For powering transistor circuits, portable instruments, and other miniature equipment, you can now get long-lasting, miniature-size Mallory Mercury Batteries in ratings of 15, 22½, 30 and 45 volts.

A unique new cell construction makes these higher voltage ratings possible at exceptionally economical price. Miniature unit cells, each hermetically sealed, are manufactured by highly automatic techniques. These cells are assembled at the factory by stacking them together, to produce any voltage output desired.

The new Mallory Mercury Batteries actually cost considerably less per hour of operation than conventional batteries. In a transistor radio, for instance, Mallory Mercury Batteries outlast ordinary batteries three to one, on continuous service. Their shelf life, too, is about five times greater.

The mercury cell, moreover, can be miniaturized *without* compromising quality or uniformity. This new construction takes full advantage of this unique characteristic . . . makes possible a variety of battery configurations to fit miniature equipment.

Ideally suited for use with transistors, Mallory Mercury Batteries have a constant-voltage, constant-current discharge. Their steady, accurate voltage output makes them useful as a voltage reference source for instrument circuits and for vacuum tube bias.

Our new Technical Bulletin gives full data on this latest advance in Mallory's continuing program of pioneering in mercury batteries. Write today for your copy, and for a consultation with one of our battery specialists on the specific requirements of your own product applications.

**Patent applied for*

Parts distributors in all major cities stock Mallory standard components for your convenience.

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Expect more . . . get more from

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., BATTERY DIV., NORTH TARRYTOWN N.Y.

For more information circle **82** on inquiry card.

PRODUCTION ENGINEERS

JOIN THE LEADER IN AERO CONTROLS!

Honeywell needs top-notch Process Engineers at all levels of responsibility for directing the production of such *airborne* control systems as:

INERTIAL GUIDANCE
INLET AREA CONTROL
JET ENGINE CONTROL
FIRE CONTROL AND BOMBING
FLIGHT CONTROL SYSTEMS
FUEL MEASUREMENT AND MANAGEMENT
EXHAUST GAS TEMPERATURE INDICATION

Engineers selected will analyze designs, establish process methods and control, and guide designs toward economical and speedy production.

■ To qualify, you should be familiar with process evaluation, cost estimating, tool ordering, metals fabrication, and manufacturing-assembly operations. Your background should be in the area of *precision* electrical, mechanical, or hydraulic devices such as gyros, accelerometers, operational computers, pressure switches, amplifiers, calibrators, altitude compensators, and thermistor level switches.

■ These are permanent, career-building positions that Honeywell can offer because of its succession of achievements in airborne control systems, broad diversification, and healthy balance between civilian and military contracts.

CONSIDER THESE ADVANTAGES

■ Minneapolis offers you metropolitan living with a suburban way of life . . . A city of beautiful lakes with every recreational facility a few minutes from your home.

■ Outstanding educational opportunities . . . Liberal tuition allowances paid by Honeywell.

■ Plant and technical facilities among the best in the industry.

■ Honeywell pays your family moving expenses.

■ Salaries, insurance-pension programs are all first rate.

■ Honeywell, the nation's leading supplier of control systems, manufactures over 10,000 diversified products. A sound growth company, Honeywell offers continuing expansion and permanent opportunities for you to advance.

WRITE TO US

If you are interested in a career at Honeywell, call collect or send your résumé to Bruce Wood, Technical Director, Dept. T-9, Aeronautical Division, 1433 Stinson Boulevard, N.E., Minneapolis 13.

MINNEAPOLIS
Honeywell
AERONAUTICAL DIVISION

NEW INSTRUMENTS

ing element into a series of pulses of constant amplitude at a frequency equal to that of turbine-meter output and, therefore, proportional to volumetric flow rate. These pulses are integrated in a dc milliammeter providing an indication proportional to frequency and hence to flow-rate.—*Fischer & Porter Co., Hatboro, Pa.*

For more information circle **224** on inquiry card.

AIR AND GAS FLOWMETER

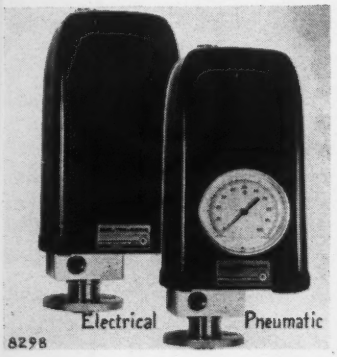
New "Series F" model of maker's "Flo-Scope," for measuring flow rates of air and gases, incorporates design changes which reduce installation costs by permitting one-man panel mounting; reduce maintenance costs by simplifying cleaning procedures. Capacities up to 75,000 cfh. Every "Flo-Scope" is individually calibrated at customer's specified flow conditions. Permanent calibration is assured because the only moving part is not subject to wear.—*Selas Corp. of America, Dresher, Pa.*

For more information circle **225** on inquiry card.

FLOW TRANSMITTERS

New "Transi-Twins" are two new pneumatic and electric transmitters for use with maker's rotameters; are said to represent "a radical and bold new approach to standardization and in-the-line performance." (1) "Mag/Nu/Matic" pneumatic transmitter employs direct force balance to minimize mechanical motion, whence low inertia and short response time. (2) "Elec/Tru/Matic" electric transmitter utilizes stain gage element. Standard model is applicable to automatic logging and data reduction.—*Brooks Rotameter Co., Lansdale, Penna.*

For more information circle **226** on inquiry card.



FORCE

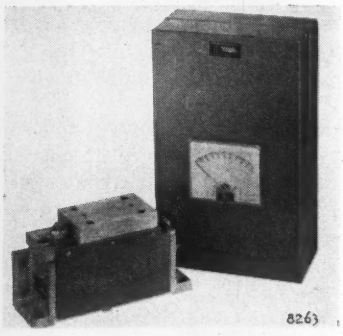
FORCE PICKUPS

New "Series 140 Force Transducers" feature improved accuracy and additional ranges; now are available in eleven models with ranges from ±10 lb to ±100,000 lb; accuracy 0.5%; excitation frequency range 60 to 10,000 cps. Maker also supplies instrumentation.—*Daytronic Corp., 216 South Main St., Dayton 2, Ohio.*

For more information circle **227** on inquiry card.

FORCE-MEASURING SYSTEM

New "Tens-A-Mech" features an electronic amplifier, a differential transformer, and a mechanical unit



BALZERS *Thin Film Optics*

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Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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Balzers means research in high vacuum process

For more information circle **83** on inquiry card.

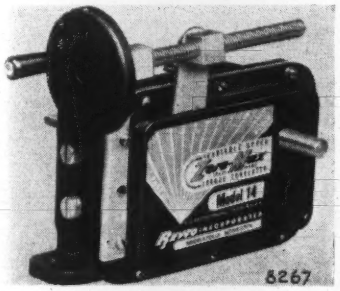
employing flexural pivots for friction-free operation, to yield uniform and accurate tension and weight measurements. Terminals are provided in amplifier for the connection of automatic control equipment. Range of standard unit is 4000 lb.—*Photron Instrument Co.*, 6516 *Detroit Ave.*, *Cleveland* 2, *Ohio.*

For more information circle **228** on inquiry card.

SPEED

VARIABLE-SPEED DRIVE

New "Zero-Max Variable Speed Reducers" feature a new sensitive screw control that provides a rotative, in-

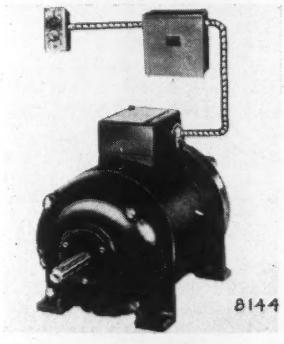


stead of linear, adjustment for precision control. Available as optional extra equipment on new "Zero-Max" units or in kit form for field installation. Easily adapted to many types of remote control.—*Revco, Inc.*, 1900 *Lyndale Avenue South, Minneapolis* 5, *Minn.*

For more information circle **229** on inquiry card.

ADJUSTABLE-SPEED DRIVE

New "300 Series" adjustable speed drive is a "low cost package" with many features "usually found on only



the most expensive equipment of this type," is available in ¼ and ½ hp models with either geared or ungeared motors. Adaptable for use in automatic control systems.—*Servo-Tek Products Co., Inc.*, 1086 *Goffle Road, Hawthorne, N. J.*

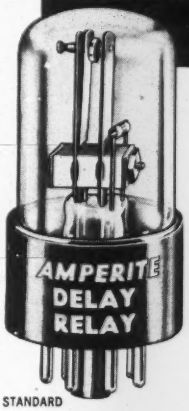
For more information circle **230** on inquiry card.

SMALL-DIAMETER AC & DC TACHOMETER GENERATORS

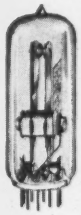
New ac and dc 3 5/16" diameter tachometer generators for industrial applications are designed for incorpo-

True Hermetic Sealing assures Maximum Stability in AMPERITE RELAYS and REGULATORS

Simplest • Most Compact • Most Economical



STANDARD


MINIATURE

Thermostatic DELAY RELAYS

2 to 180 Seconds

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- *SPST only* — normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from —55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and — *inexpensive!*

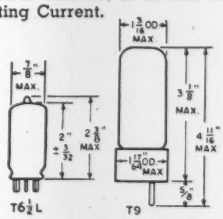
TYPES: Standard Radio Octal, and 9-Pin Miniature

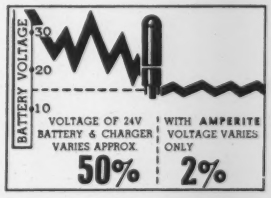
PROBLEM? Send for Bulletin No. TR-81

Also — **Amperite Differential Relays:** Used for *automatic overload, under-voltage* or *under-current protection.*

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp.) ... For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.





T9 BULB

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55° to +90° C.), or humidity ... Rugged, light, compact, most inexpensive.

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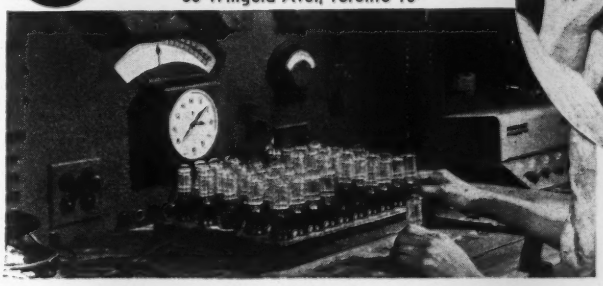


Individual inspection and double-checking assures top quality of **Amperite** Products.

For more information circle **84** on inquiry card.

OXYGEN

key to modern industrial processes

Control it with...

Arnold O. Beckman INC.

OXYGEN ANALYZERS!

Oxygen is one of the most important factors found in modern chemical and industrial processes. Whether to minimize product oxidation (prepared atmospheres, air infiltration, etc.) ... or to insure adequate oxygen for efficient combustion (boilers, kilns, etc.) ... or to control oxygen for proper process operations (ammonia, acetylene, air fractionation, etc.) oxygen control has become too important in today's operations for any profit-minded executive to overlook.

And because they are the *only* instruments that measure oxygen content directly, accurately and conveniently, Arnold O. Beckman Oxygen Analyzers have become the leading instruments for modern oxygen control in a wide range of applications—from catalytic refineries to cement kilns—from power plants to personnel protection.

These instruments (and systems) can be built to meet *your individual* needs.

These instruments offer many unique advantages...

SELECTIVITY: Highly sensitive to oxygen. Effects of gases other than oxygen are negligible.

HIGH ACCURACY: 1% of full scale (Example: ±0.05% O_2 on range 0-5% O_2).

MANY RANGES: Full scale ranges from 0-1000 ppm or up to 0-100% O_2 available. Combustion ranges 0-5, 0-10, 0-15% O_2 supplied with 0-25% O_2 check range. Multi-range instruments available.

RAPID RESPONSE: Standard Analyzers—95% response in less than 1 minute. Special Units—95% response in 7 seconds!

USE ANY RECORDER: Millivolt output for potentiometers; current output for miniature electronic recorders and galvonometers; air output for pneumatic receivers and control systems.

PACKAGE UNITS: Analyzers and controls may be built into a cubicle with sampling components wired, piped, and ready for installation as a single unit.

SAMPLING SYSTEMS: Complete standard systems—components, package or portable units are available.

OTHER ADVANTAGES: Instruments may be mounted in explosion-proof cases, mounted indoors or outdoors, in portable panels, and have other desired features.

Model F3: Ranges of 0-1%, 0-5%, 0-10%, and higher. Meter on door for convenient readings at sampling point.

Model G2: Full scale ranges 0-0.1%, 0-0.5%, and others for low O_2 content. Ranges 90-100%, 95-100% O_2 for high O_2 content.

The above are but two of the complete line of Arnold O. Beckman Oxygen Analyzers available for every requirement.

Send for helpful free literature which describes Arnold O. Beckman instruments in detail. When writing, outline your particular application—we'll gladly supply specific information.

Ask For Data File 206-116

Arnold O. Beckman INC.

ANALYZERS

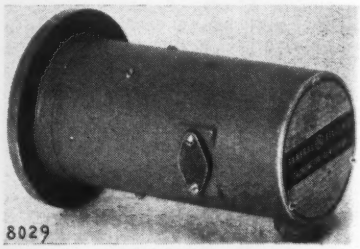
Profit Builders for Industry

1020 Mission Street

South Pasadena, California

For more information circle **85** on inquiry card.

NEW INSTRUMENTS



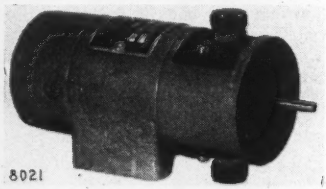
8029

ration into variable-speed drive systems; are totally-enclosed and of ball-bearing construction. New 4-pole a: model serves speed range of 400-500) rpm; output 28 v per 1000 rpm, plus or minus 10%. Dc model features low shaft inertia (1.4 lb-in^2) and low (1.5%) ripple; option of 50 or 100v/ rpm.—*Specialty Component Moto Dep't, General Electric Co., Schenectady 5, N. Y.*

For more information circle **231** on inquiry card.

TEMPERATURE-COMPENSATED TACHOMETER GENERATORS

New temperature-compensated dc tachometer generators can be furnished with outputs held to less than



8021

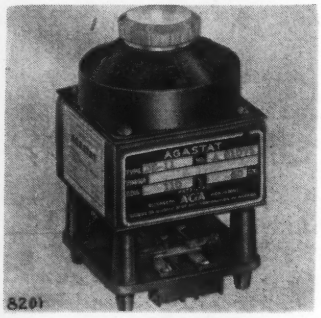
0.1% or to less than 0.25% voltage variation due to temperature changes over a range of −40°C to 100°C. This greatly increased accuracy over the 5% to 7% variation suffered by uncompensated units obviates all need for costly or complicated external compensating networks. Six basic frame sizes; outputs from 1 to 175 v per 1000 rpm.—*Electric Indicator Co., 100 Camp Ave., Springdale, Conn.*

For more information circle **232** on inquiry card.

TIME

TIME DELAY RELAYS

New dial head "Agastat" time delay relays, for applications requiring frequent time adjustments, feature calibrated dials which are color-coded



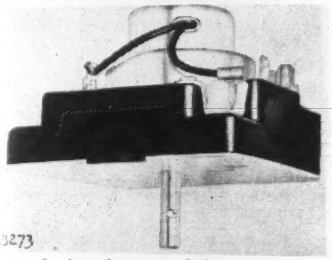
8201

to identify four timing ranges: white 0.1-3 sec, yellow 0.1-10 sec, red 10-120 sec, blue 0.5-15 min.—*A'G'A' Div., Electric Stop Nut Corp., Elizabeth, N. J.*

For more information circle **233** on inquiry card.

AUTOMATIC TIMER

New dust- and dirt-proof "Model 102 Circuitrol Interval Timer" features dual-purpose case which enclos-

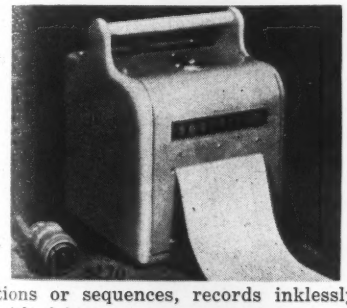


es and insulates while supporting switch blades; is rated 25 amp 250 v. —*Soreng Div., Controls Co. of America, 9555 Soreng Ave., Schiller Park, Ill.*

For more information circle **234** on inquiry card.

SEQUENCE TIMER-RECORDER

New portable "Monitorecord," for timing and recording as many as fourteen simultaneous machine opera-

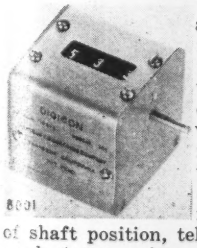


tions or sequences, records inklessly with 0.01-sec accuracy; can operate on control circuit of machinery, and gaging and inspection equipment while machinery is running.—*Autometrology Div., The Sheffield Corp., Dayton 1, Ohio.*

For more information circle **235** on inquiry card.

COUNTING

COMBINATION MECHANICAL & REMOTE INDICATING COUNTER

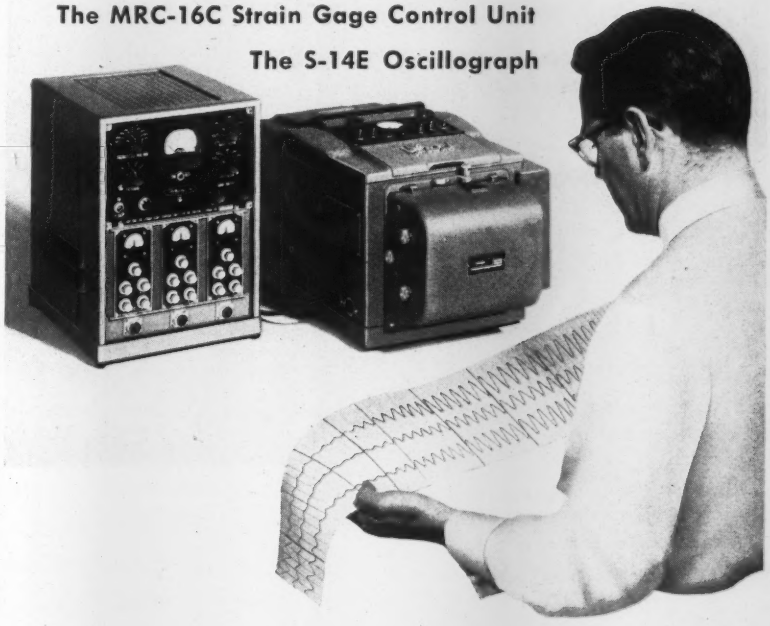


New "Digicon" and "Digipot" are mechanical totalizing counters with either ten contacts or one voltage-dividing resistor coupled to each visual indicator wheel, for remote indication of shaft position, telemetering, direct readout to card-punching equipment, remote control of communications

BASIC SYSTEM
for Dynamic Analysis

The MRC-16C Strain Gage Control Unit

The S-14E Oscillograph



IN CONTINUOUS RECORDING of static or dynamic quantities, the Hathaway MRC-16C Strain Gage Control Unit and the Hathaway S-14E Oscillograph have no equals. The accuracy, portability and clear, clean records produced by these two units working together make this instrument team your best possible investment.

SPECIFICATIONS

THE MRC-16C

AMPLIFIER ELEMENTS: Available for use in any combination.
Carrier Amplifier: 0 to 1500 cps
Wide Band Amplifier: 2.5 to 6000 cps

CONTROL UNIT
Voltmeter: Has 2 scales for continuous monitoring of carrier or gage voltage and serves as a bridge balance indicator.
Power Supply: Supplies filament and regulated plate voltages to the oscillator and amplifier elements from 115 volt, 60 cycle.
Gage Factor Control: Continuously adjustable over a range of 1.9 to 2.2.

SIZE: 15 x 12 x 16 inches

WEIGHT: 50 pounds

THE S-14E

VERSATILE RECORDING CHANNELS: Uses any combination of 6 to 24 coil, bifilar or multi-element type galvanometers.

AUTOMATIC LAMP-BRILLIANCE CONTROL: Insures clear records.

CHART DRIVE SYSTEM: Quick change transmission—a range of 9 speeds easily selected—1/10 to 600 in./sec.

CONTINUOUS DRIVE RECORD MAGAZINE: Accommodates 6 inch record of any desired length up to 300 feet.

POWER: 115 volts; 50-60 cycles

WEIGHT: 60 pounds

OPTIONAL ACCESSORIES:
Synchronous time marker
Record numbering device
Trace identifier
Drum-type record magazine with high-speed shutter attachment

Write for Bulletins 4-6H and 1-4H

HATHAWAY INSTRUMENT DIVISION
HAMILTON WATCH COMPANY

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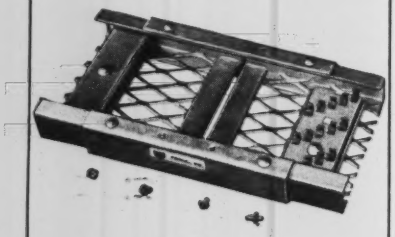
			Midwest 4-9004		

For more information circle **89** on inquiry card.

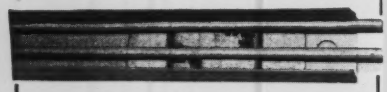
SPECIFY

P-W

for Supporting Instrument Tubing



P-W Manufactures a complete trough system with channel connectors. Drive rivets are used for quick assembly.—Extension Connectors eliminate field cutting—Adjustable connectors for any change in direction or elevation—1 Section for long spans—Tube Clips—Cushion Clamps



Raceway to support a limited number of tubes with connectors, elbows, tees, etc.—Bulkhead Bar. P-W systems are available in widths from 1" to 24" and in lengths from 1' to 16'.

Twist-Rack

The Structure To Support Tubetrof . . . Cabletrof . . . Shelving . . . Conduit . . . Cables . . . Pipe, Etc.

Write today for Bulletin 656-G

P-W INDUSTRIES, INC.
Duncan & Melrose Sts.,
Philadelphia 24, Pa.

(Representatives to serve you!)

For more information circle **157** on inquiry card.

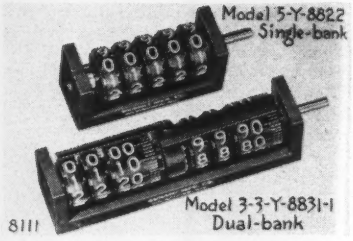
NEW INSTRUMENTS

equipment and as components of analog and digital servo systems. Counters are rated 1000 rpm continuous duty or 2000 rpm intermittent duty. Life without maintenance exceeds 50 million counts.—*Anatran Corp.*, 165 *East California St., Pasadena, Calif.*

For more information circle **236** on inquiry card.

INSTRUMENT COUNTER

New "Y Instrument Series" comprises 96 different models, each with identical configuration of case, wheels, and components; permits manufacturer to have continuity throughout various types of equipment. Weights from ¾ oz to 3½ oz.—*Durant Mfg. Company*, 1914 *No. Buffum St., Milwaukee* 1, *Wis.*

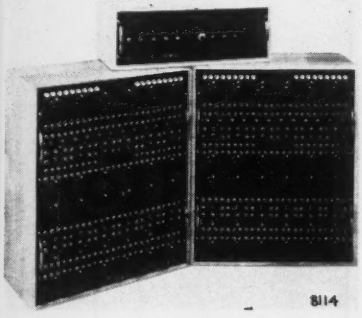


For more information circle **237** on inquiry card.

COMPUTING and DATA PROCESSING

ANALOG COMPUTERS

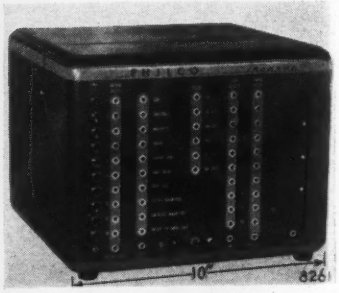
New "Models GPS-6 and GPS-12 General Purpose Simulators" are available with a wide variety of maker's linear and nonlinear computing elements and special function generators; can perform complete problem solutions up to 50 times per second, allowing the research operator to change problem parameters and observe instantaneously and continuously the resulting changes in problem solutions.—*GPS Instrument Co., 811 Boylston St., Boston, Mass.*



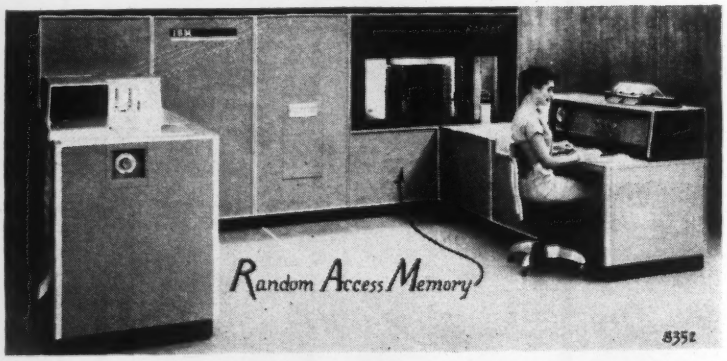
For more information circle **238** on inquiry card.

PORTABLE COMPUTER

New "Transac" arithmetic computer occupies ⅓ cu ft; weighs less than 12 lb; operates on 3 v; employs maker's unique direct-coupled circuitry (eliminating many components usually found in electronic computers); contains nearly 1,000 transis-



ELECTRONIC DATA-PROCESSING MACHINES



New "RAMAC" (illustrated) and "RAM 650," both designed for high-volume in-line processing of business data, feature a radically new type of random-access memory known as "juke-box" because it comprises fifty magnetic discs arranged in a vertical stack. Data are recorded on, and read from, both sides of each disc. There are 100 tracks on each side and each track holds five 100-character records. Stack rotates at 1200 rpm and any address can be located in milliseconds. —*International Business Machines 590 Madison Ave., New York* 22, *N. Y.*

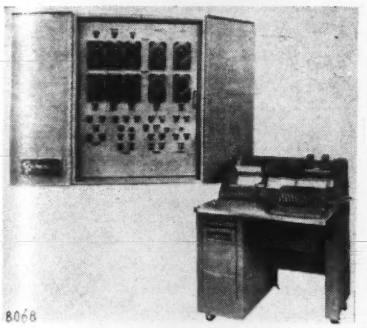
For more information circle **239** on inquiry card.

ors, 300 resistors and 12 capacitors permanently dip-soldered into compact plug-in printed-circuit cards. Each card provides all the necessary functions for one binary digit including add, subtract, multiply, divide, square root, shift right, shift left, sign magnitude and absolute magnitude. Ten "math" cards and seven "control" cards are plugged into unit to provide all arithmetic processing facilities between conventional input and output devices. Computer adds two numbers in 1.5 usec; multiplies in 15 usec; provides visual display of results.—*Philco Corp., 4700 Wissahickon Ave., Philadelphia, Pa.*

For more information circle **240** on inquiry card.

PUNCH-CARD-RECORDING PROPORTIONAL PANEL

New fully-automatic electronically-controlled proportioning system combines automatic proportioning features of maker's "Select-O-Weigh" control system with an IBM printing summary punch. Information is transmitted from "Select-O-Weigh" system by means of maker's digitizing equipment, which digitizes individual weighing and sends information to an IBM Type 526 summary punch. Thus, user can process billings, maintain inventory control, etc., by processing punched cards through an IBM business machine.—*Richardson Scale Co., Van Houten Ave., Clifton, N. J.*



8068

For more information circle **241** on inquiry card.

COMPUTER ACCESSORIES

New additional standard and optional features offered as part of production-line "ELECOM 125" systems: (1) "ELECOM File Processor" is now optionally equipped to perform a simultaneous collate-select-separate operation. (2) High-speed punched-tape readers and punches may be attached to "ELECOM File Processor." (3) "ELECOM 125" computer's main memory has been increased to 4,000 ten-digit words standard with capacities of 6,000, 8,000 or 10,000 words available optionally. (4) In addition to main memory, 50-words standard or 100-words optional rapid-access memory are now available. (5) Magnetic tape input and output to computer have been increased to standard rate of 6,000 digits per second. Input or output of magnetic tape proceeds in

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PRECISION VERNIER CALIPER

Dull chrome plated,
will not crack or peel
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Read inside, outside and depth
measurements from the same scale
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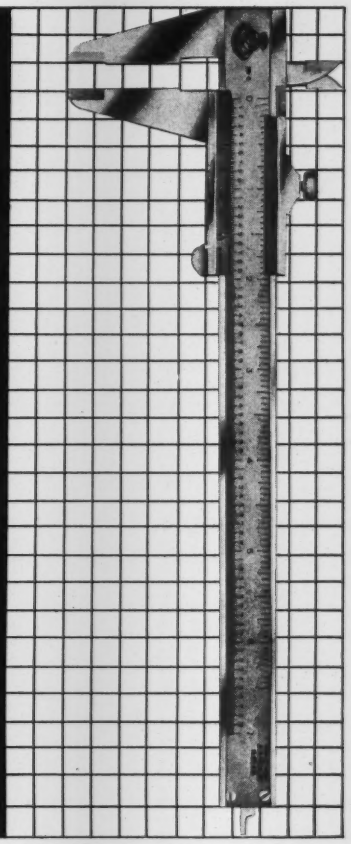

For more information circle **87** on inquiry card.

The
Curtiss-Wright "SNAPPER"

NEW CONCEPT... ADVANCED DESIGN IN THERMAL TIME DELAY RELAYS

Designed for high performance and long life, the Curtiss-Wright "SNAPPER" Thermal Time Delay Relay is proving itself in countless applications involving time delay in electrical circuits. Such applications include circuits to provide definite on-off time intervals to delay the application of high voltage until after warm-up period and for over and under voltage protection with simultaneous fault indication.

These relays have single-pole double-throw contact action, high ambient temperature range, freedom from chatter and arcing, and are small in size. The "SNAPPER" thermal time delay relays are factory pre-set from 3 to 90 seconds. They are available in metal envelope, miniature (7 and 9 pin) or octal (8 pin) and in a glass envelope in 9 pin only.

Curtiss-Wright manufactures the High-Low "SNAPPER" Differential Thermostat with high precision characteristics. Write to Thermal Devices for complete data.

ELECTRONICS DIVISION
CURTISS-WRIGHT
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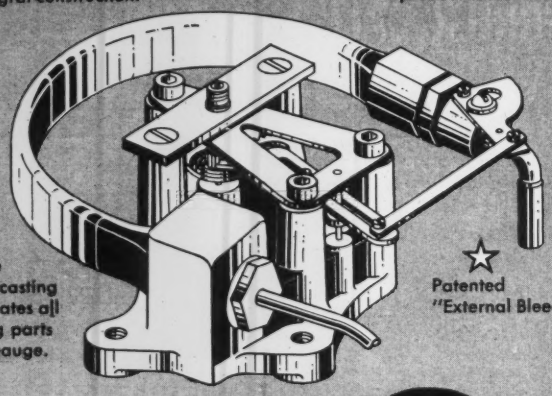
For more information circle **88** on inquiry card.

HEISE GAUGES

Permanent positive accuracy of alignment guaranteed by integral construction.

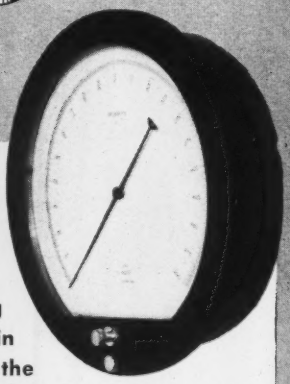
Weldless heat treated Bourdon tube maintains precise calibration.



Massive Bronze casting coordinates all working parts of the gauge.

Patented "External Bleeder"

Dial individually engraved with reference to the pressure gradient of its gauge mechanism.



ACCURACY

The standard of excellence maintained by Heise qualifies this instrument for the most exacting requirements. Designed to maintain permanently its inherent precision, the Heise gauge is often used in place of the dead weight tester in checking other instruments. Consistently accurate performance as a calibration reference has established its recognition as THE STANDARD OF THE WORLD.

SPECIALIZATION AND EFFICIENCY

Heise Laboratories have always specialized in the design and production of high precision pressure gauges. The highest standards of quality control protect the manufacture and assembly of each component and the permanent calibration of the finished instrument.

Efficiency in the production of one type instrument, precision pressure gauges, has made it possible to maintain a prompt delivery schedule.

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Pressure Range 15 to 20,000 P.S.I.
Dial Sizes 8½"—12"—16"
Prices from $151.60

Catalog on Request

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BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **90** on inquiry card.

NEW INSTRUMENTS

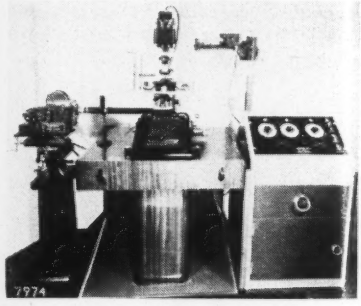
parallel with computation, but an additional optional buffer is available allowing both input and output of magnetic tape in parallel with computation. (6) A new "ELECOM High-Speed Line Printer" operating at a rate of 900 120-character lines per minute is available.—*Electronic Computer Div., Underwood Corp.*, 35-10 *36th Ave., Long Island City* 6, *N. Y.*

For more information circle **242** on inquiry card.

PHOTOGRAPHY

MOTION-PICTURE APPARATUS

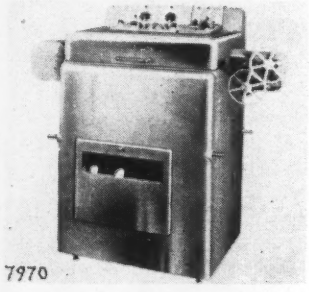
New "Model SSX Cine-Photo Apparatus" is absolutely vibrationless; has safety clutch to avoid film tearing; can be adapted to any 16-mm camera even if camera has no provision for single-framing. Entire equipment for time-lapse studies can be used with all types of photomicrographic apparatus, or without a microscope. Framing frequencies from 2 sec to 2 hr; exposure times from 0.1 sec to 20 sec; also push-button advance of one frame for checking.—*Opplem Co., Inc.*, 83 *Uhland St., East Rutherford, N. J.*



For more information circle **243** on inquiry card.

FILM PROCESSOR

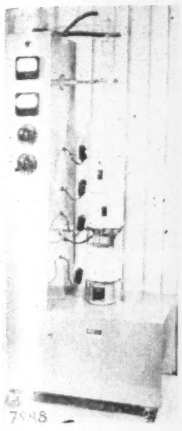
New "Type T246 MK 3 Automatic Tri-Film Processor" can process 16-mm, 35mm and 75 mm films by simple adjustments; features simplified loading procedure, fine control over processing; temperature-controlled solutions and dryer.—*Norden-Ketay Corporation*, 99 *Park Avenue, New York, New York.*



For more information circle **244** on inquiry card.

LAB EQUIPMENT

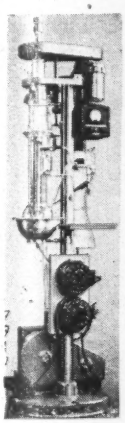
AGITATED POT STILL



New "Model P" improved type of high vacuum pot still is said to be "the first of its kind to utilize direct agitation of the distilland"; is capable of limited fractionation of organic materials up to a molecular weight of 700, "with results superior to any conventional distillation equipment." Distilland capacity 2 l; output 1 lph; vacuum range to 0.1 micron Hg; temperature range to 300°C or higher. —*Arthur F. Smith Co., Rochester 3, N. Y.*

For more information circle **245** on inquiry card.

HIGH-VACUUM STILL

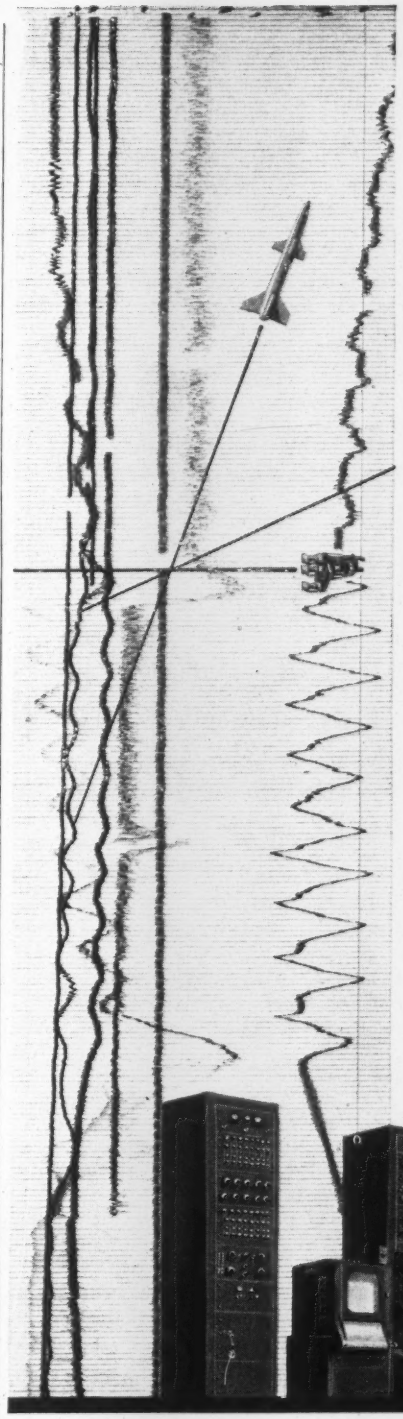


New "Type 4010-01 Brush Still" batch-type lab unit separates heat-sensitive materials with molecular weights up to 900 at pressures as low as 1 micron Hg; is adaptable to a wide variety of distillation techniques; distilland capacity 100 to 1500 cc; distillation rate from a few drops to 100 cc/min; exact regulation of distillant boiler up to 300°C.—*Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **246** on inquiry card.

MAGNET CHARGER

New magnetizer generates a field intensity of up to 500,000 gauss for use in production and testing of magnets and in high-intensity field experiments, yet has a maximum line demand of only 6.6 kva. It utilizes stored-energy principle to produce 1500-kva peak inpulses of up to 50 milliseconds duration. Equipment comprises an 1800-mfd capacitor storage bank which is discharged through an ignitron tube to the primary of a step-down transformer whose single-turn secondary acts as the magnetizing loop. Peak pulse output (200,000 amp) can magnetize up to 75 lb. of Alnico V. Control circuits assure precise field output, uniform from pulse to pulse. Because of field's high intensity, special-shape magnets (such as those which form an almost completely closed circuit or in which air-gap reluctance is less than that



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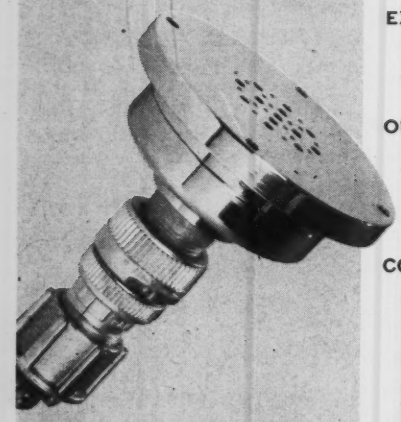
ANNOUNCING

a new, superior way to measure dynamic pressures accurately

Extremely high output over a wide frequency range—coupled with *low internal impedance*—make the CEC Type 4-340 an ideal pickup for applications requiring undistorted response to dynamic pressure waves. Such applications include the measurement of complex pressure waves caused by sonic vibrations . . . blast pressures . . . water hammer in liquid-filled lines. Offered exclusively by Consolidated, the new self-generating Dynamic Pressure Pickup utilizes the *Electrokinetic Principle* . . . gives you many superior advantages:

CEC's new type 4-340 *Dynamic* PRESSURE PICKUP

exclusive advantages



IDEAL RESPONSE with no phase lag or overshoot. Variations in frequency have negligible effect on the output between limits of 3 cps and 25,000 cps.

EXTREMELY HIGH OUTPUT—approximately 350 mv/psi self-generating over a pressure range of 10^{-4} to 100 psig.

OUTSTANDING STABILITY — Calibration is retained in spite of extreme temperature and pressure cycles, shock, and vibration.

COMPLETE FLEXIBILITY—Almost any electronic readout device can be used without amplification. At high frequencies, output may be fed directly into an oscilloscope. In low frequency ranges, galvanometers requiring less than 300 μa for full-scale deflection may be used directly.

For complete data, please write for Bulletin CEC 1573-X10

Consolidated Electrodynamics

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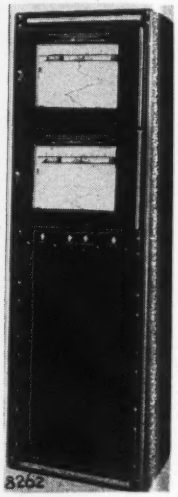
For more information circle **92** on inquiry card.

of magnetic material) can be readily magnetized. Since single-turn magnetizing loop can be readily removed and replaced, magnets do not have to be disassembled and then reassembled; nor do they require time-consuming wrapping with wire. In testing, magnetic material is first magnetized, then measured for flux density.—*Commercial Eqpt. Div., Raytheon Mfg. Co., Waltham, Mass.*

For more information circle **247** on inquiry card.

F-P APPARATUS



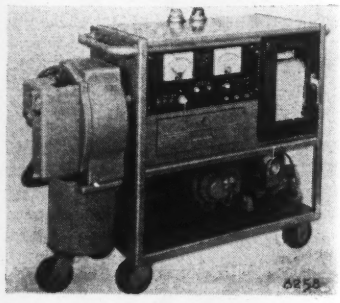
New Freezing Point Apparatus comprises an automatic range-changing recorder calibrated directly in °C for use with a precision platinum resistance thermometer. Each range has a span of 10 C°, accuracy 0.01 C°. Any number of overlapping 10C° ranges available to cover any desired range between −260°C and 600°C. Optional: a second temperature difference recording controller to control bath temperature with respect to sample temperature.—*Phoenix Precision Instrument Co., Inc., 3803-05 N. 5th St., Philadelphia 40, Pa.*

For more information circle **248** on inquiry card.

NUCLEONICS

AIR MONITOR

New "Model AM-3A" mobile air monitor with fixed or moving filter automatically measures and records



airborne radioactivity; warns by light and bell when preset limits are exceeded; will operate for 7 to 10 days unattended, providing a permanent legal record on a continuous chart.—*Nuclear Measurements Corp., 2460 W. Arlington Ave., Indianapolis, Ind.*

For more information circle **249** on inquiry card.

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For more information circle **93** on inquiry card.

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AURORA, ILLINOIS • NORWALK, CALIFORNIA

For more information circle **94** on inquiry card.

PORTABLE SCALER

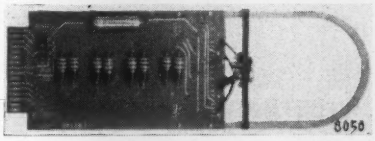
New 24-lb "Model 2101," for measurement tasks in lab radioassay and medical diagnosis applications, is said to be the "first low-cost scaler to provide a high-voltage supply stable within 3 v over-all," also has built-in timer to collect counting rate data; features a rare facility for counting gamma scintillations by virtue of 1-part-in-1000 voltage adjustability; enables operator to discriminate against backscatter radiation to obtain high accuracy in gamma-ray measurements.—*Dept. 5439, Berkeley Div. Beckman Instruments, 2200 Wright Ave., Richmond, Calif.*

For more information circle **250** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

PRINTED CIRCUITS

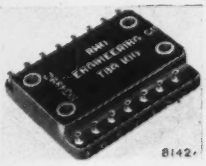
New source of supply is announced. Illustrated example, for computer applications, features a handle which en-



ables entire circuit to be withdrawn and replaced as a plug-in assembly.—*Laboratory for Electronics, Inc., 75 Pitt St., Boston 14, Mass.*

For more information circle **251** on inquiry card.

ENCAPSULATED CIRCUITS

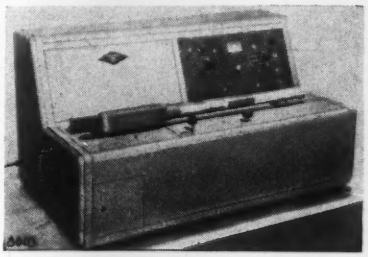


New "Rhomized Circuitry" encapsulation process permits construction of circuits in shockproof, altitude-proof, and humidity-proof modular units, with practically no limitations on size or configuration.—*Rho Engineering Co., 2242 Sepulveda Blvd., Los Angeles, Calif.*

For more information circle **252** on inquiry card.

TORQUE WRENCH TESTER

New torque wrench calibrator measures torque by means of special "SR-4" resistance wire strain-gage type torque pickups; is of rugged design; easy to use; covers a wider range of torque testing capacity than available



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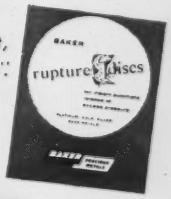

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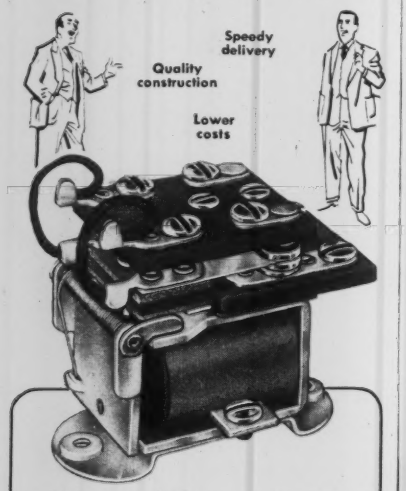
AEMCO

and get more for your relay dollar!



Pick the size you want . . . choose the features you need . . . you're sure to find an AEMCO relay that will meet or exceed your specifications. Compact in design, dependable in performance, AEMCO relays are the choice of more than 100 top names in American industry—here's why:

CAN TYPE

Lower cost—due to modern production techniques and fresh, new engineering ideas. All AEMCO products are designed with shortcuts and specific production economies in mind.

PLUG-IN BASE

Top quality—based on more than 30 years experience. We'll work closely with your design engineers, and we'll do it without red tape or confusion.

HERMETICALLY SEALED

Many standards—to choose from. AEMCO relays are available in a wide variety of spring and coil combinations, operating potentials, contact ratings and enclosures.

OPEN TYPE

Speedy prototype delivery—and quick tool-up for production on custom types. Yes, at AEMCO we're selling service as well as design and manufacturing ability.

Write Today

Your inquiries are invited. For information on the complete AEMCO relay line, write for your free copy of Bulletin "H".

AEMCO INCORPORATED
84 State Street • Mankato, Minn.

For more information circle **96** on inquiry card.

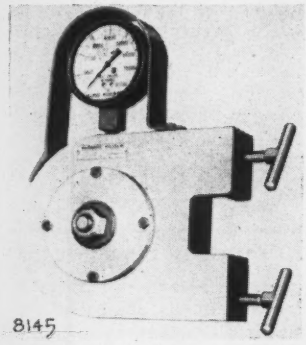
NEW INSTRUMENTS

heretofore in one unit.—*Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., 806 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **253** on inquiry card.

BOLT-TENSION CALIBRATOR

New portable and direct-reading bolt tension calibrator permits impact wrenches to be adjusted and set

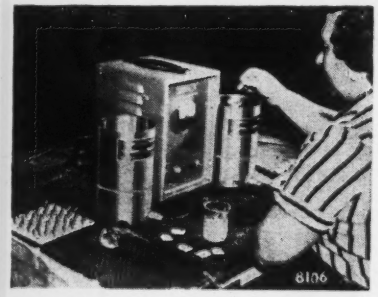


wherever they are to be used.—*Skidmore-Wilhelm Mfg. Co., 442 Green Rd., Cleveland 21, Ohio.*

For more information circle **254** on inquiry card.

ULTRASONIC CLEANER

New "Model AP-10-B Sonogen" for washing small parts that must be "surgically" clean, has a 36-40-kc

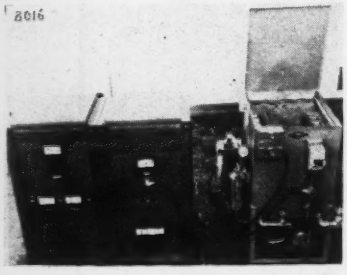


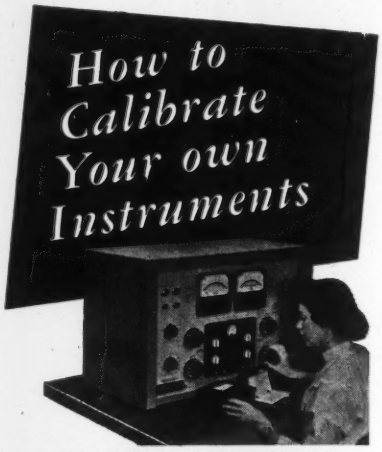
generator with RF power output of 50 watts average, 200 watts peak on pulses. Tanks are of 1-pint, 1-quart, or ½-gallon capacity.—*Branson Ultrasonic Corp., 37 Brown House Rd., Stamford, Conn.*

For more information circle **255** on inquiry card.

ULTRASONIC CLEANER

New "CB1-60" has a single-stage tank, 20" x 24" x 40" providing a



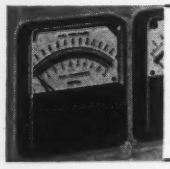


FAST ACCURATE CALIBRATION
Now possible with one completely self-contained AC-DC calibration standard requiring a minimum of operator training and previous instrument calibration experience.

Use the Compact Model 829 INSTRUMENT CALIBRATION STANDARD for
✓ LABORATORY STANDARDS
✓ PRODUCTION TESTING
✓ INSTRUMENT REPAIR
✓ INSPECTION & SERVICE

All Circuits, Power Supplies and Standards are contained in One Single Cabinet!

Precise, practically error-proof checking of most types of electrical indicating instruments in daily use is a routine convenience for Model 829 users. Maintenance of quality control by frequent calibration of instruments and allied test equipment can be accomplished within departments by available personnel. A mechanical index explains step-by-step test procedure.



WESTON Special Meters
used as standards have 5-inch mirror precision scales, knife edge pointers and are adjusted to better than 0.2% accuracy.

Calibration to full scale accuracy of 0.5% can be accomplished for all instruments measuring d-c voltage (22 ranges) from 0.25 mv to 2000 volts, d-c current (22 ranges) from 2 μa to 20 amperes, a-c voltage (19 ranges) from 1.5 mv to 1500 volts, and a-c current (14 ranges) from 1.5 ma to 20 amperes. Net price $2345. FOB Boonton, N.J.

Write for Technical and Application Data.

Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **97** on inquiry card.

working space of 12" x 12" and utilizing barium titanate transducers. Concentrating high ultrasonic power in one cubic foot of area, it offers one of the highest cleaning potentials in the field, plus a substantial saving in cleaning and down-time.—*Curtiss-Wright Corp., Caldwell, N. J.*

For more information circle **256** on inquiry card.

SEALING MATERIALS

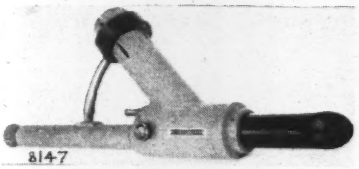
New "O-ring Compounds 37-076 and 590-5" are synthetic materials for molding seals needed in electrical switch boxes and other electrical closures; are serviceable to −20°F; meet MIL-G-18586.—*Rubber Products Div., Parker Appliance Co.,* 17325 *Euclid Ave., Cleveland* 12, *Ohio.*

For more information circle **257** on inquiry card.

INSPECTION

INSPECTION PERISCOPE

New periscope is 30" long, has a viewing head diameter of 2⅜" up to point where it is inserted into fuel

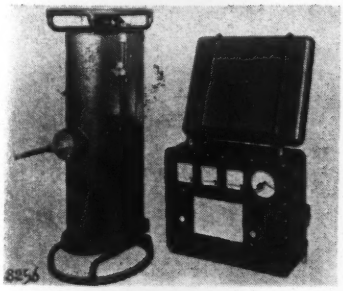


tank or other vessel to be inspected. A zirconium arc lamp, which remains outside tank, casts a strong light beam into tank by means of a separate optical system. Field of view is illuminated so intensely that even seams and imperfections of black rubber lining can be scrutinized. Operator can tilt field to inspect any inside point, including wall through which periscope is inserted.—*Testa Mfg. Co.,* 10130 *East Rust St., El Monte, Calif.*

For more information circle **258** on inquiry card.

INDUSTRIAL X-RAY UNITS

Four new portable ruggedly-constructed industrial x-ray units for radiographic inspection of castings, welds and assemblies are announced. "Models MS-200, MS-260 and MS-300" (illustrated) are designed specifically for heavy-duty work; "Model MS-140" is a smaller trepanning unit for spot examination of welds and light



ABSOLUTE PRESSURE INDICATOR
...For Precise Vacuum Work

Accuracy: 1/300 of full scale
Sensitivity: 1/500 in *all* ranges
Ranges: 0-50mm Hg. 0-100mm Hg.
0-200mm Hg. 0-410mm Hg.
0-800mm Hg. 390-800mm Hg.
Dial Sizes: 2¾" or 6" diameter for all ranges
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WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
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MERCHEN GRAVIMETRIC FEEDERS & METERS
for dry free-flowing materials

- automatic batch control
- continuous blending
- materials accounting

Accuracy 1%
Rates 3 to 3000 lbs. per min.

Write for Bulletin No. M-32

WALLACE & TIERNAN
INCORPORATED
25 MAIN ST., BELLEVILLE 9, N. J.

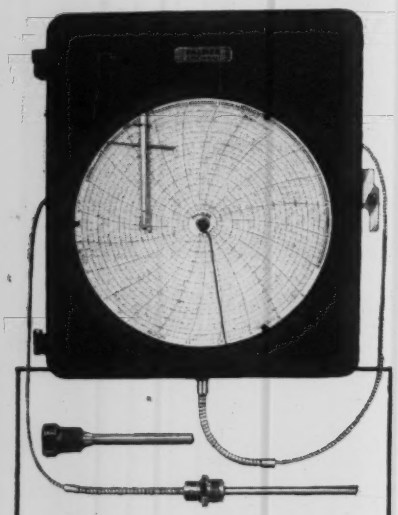
For more information circle **98** on inquiry card.

PALMER

MERCURY ACTUATED

recorders

Into this modern Mercury Actuated Recorder has gone all the skill of Palmer master craftsmen.



Readings are clearer, smoother and more precise than ever thought possible. In fact readings are so amazingly improved that maintenance is never needed under normal uses.

Recording Thermometers feature twelve inch die-cast aluminum case with black wrinkle or white satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 to 1000°F. or Equivalent in °C.

Send for Bulletin No. 45

Consult your Classified Directory

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

Cincinnati 12, O.

For more information circle **99** on inquiry card.

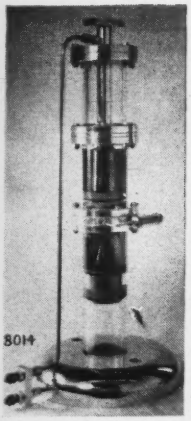
NEW INSTRUMENTS

radiography. All are easy to operate, fully protected against mechanical and electrical failure, adaptable to most industrial plant voltages, and give highest possible detail and contrast radiographs in the shortest time. —*Mitchell Radiation Products Corp.*, 128 *E. Washington St., Norristown, Pa.*

For more information circle **259** on inquiry card.

MECHANICAL TESTING

DYNAMIC SHOCK TESTER



New "Hyge Actuator," said to be a "revolutionary new dynamic shock testing instrument," accurately simulates shock experienced by equipment in actual use; is no larger than a golf bag, yet can produce extremely high loads instantaneously and exactly, with precision waveform control. Illustrated is a part-plastic demonstration model showing typical arrangement of modular components. Unique performance characteristic is ability to apply widely varying forces for controlled periods of time.—*Consolidated Electrodynamics Corp.*, 1775 *Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **260** on inquiry card.

SURFACE ABRASION TESTER

New automatic "Model 174" of maker's dual-wheel "Abraser" quickly determines resistance to surface

abrasion of materials under cold, wet and dry conditions; features new built-in automatic counter and stop switch; comes with various holders for testing textiles, metals, sheer silks, leather, rubber and linoleum for industries such as automotive, aircraft, chemical, paint, plastic and coatings. —*The Taber Instrument Corp.*, 111 *Goundry St., Section* 61, *North Tonawanda, N. Y.*

For more information circle **261** on inquiry card.

now available . . .

DUCTILE BISMUTH WIRE

with all the advantages of bismuth—yet

- **Pliable**
- **Ductile**
- **Will not age—harden or crystallize as regular extruded bismuth.**
- **Has tensile strength to 2500 psi**

BISMUTH is the most diamagnetic of all metals; has highest Hall coefficient for ductile metals; has greatest resistance change in a magnetic field; has greatest resistance of pure ductile metals per mil ft.; has lowest thermal capacity; has least thermal conductivity; has highest negative thermocouple voltage per degree change; has most rapid thermocouple response; an alloy (symbol "A") has highest positive thermocouple voltage.

DUCTILE BISMUTH WIRE has all of these advantages in addition to the ones listed above. Our special process has made the bismuth more pliable and ductile without changing the basic physical properties.

Fitzpatrick Electric Supply Co.

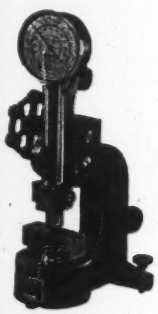
444 Irwin St. Muskegon, Mich.

For more information circle **100** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 50 years.

In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.



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Illustrated bulletins free

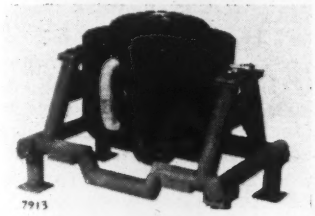
The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway Jamaica 35, N. Y.

For more information circle **101** on inquiry card.

VIBRATION SHAKER

New "Model 174" is the second in new series of "wide-band" shakers for higher frequency operations and

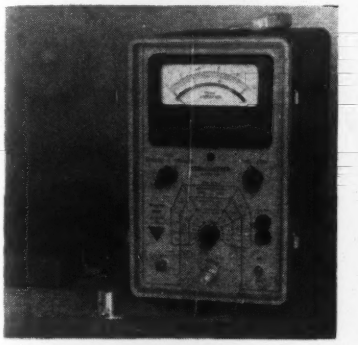


lower input requirements. Force output 1500 lb; 130 lb load for 10*G* vector and 55 lb for 20*G* vector, recommended stroke ±0.25" for continuous duty. Weight 2000 lb.—*The Calidyne Co., Winchester, Mass.*

For more information circle **262** on inquiry card.

VIBRATION & MOTION TESTER

New "Model 12A Vibrometer" measures acceleration, velocity and displacement of mechanical vibrations



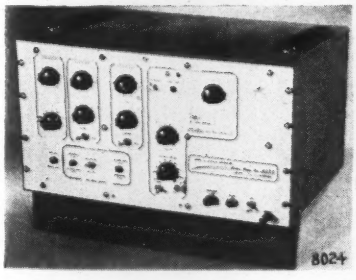
from 3 to 20,000 cps; displacements as small as 0.0001" and as great as 3"; velocities from 0.03 to 1000 ips; accelerations from 0.03 to 780 *G*. Used with oscilloscope, it permits quantitative analysis of impact shock and impulsive motions.—*Televiso Corp., 1415 Golf Road, Des Plaines, Ill.*

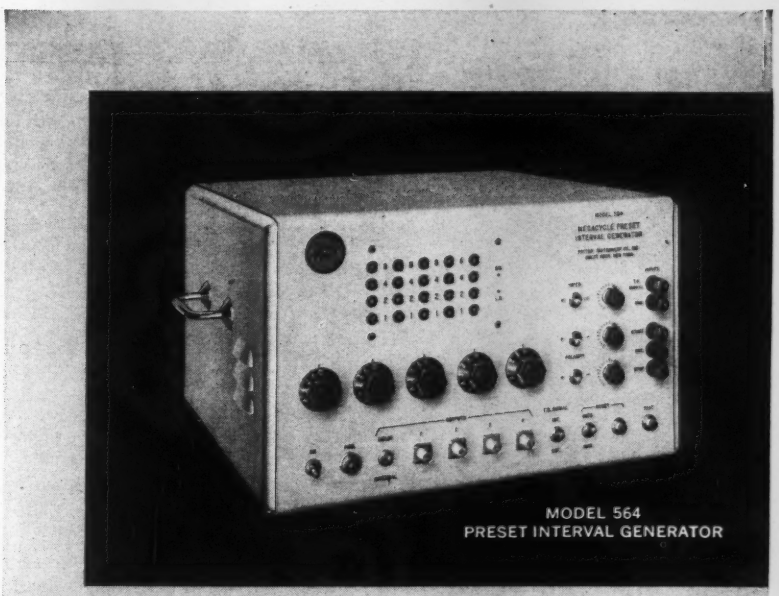
For more information circle **263** on inquiry card.

ELECTRICAL TESTING

PULSE GENERATOR

New "Model 2125A" provides an economical source of fast rise-time pulses for a wide range of lab and





DIGITAL
PRESET INTERVAL
GENERATOR

EXACT DIGITAL SELECTION
NO CALIBRATION REQUIRED
SINGLE RANGE 100,000 STEPS

The "PIG" will —
GENERATE DELAYS
GENERATE PULSE BURSTS
GENERATE VOLTAGE GATES
MEASURE TIME INTERVALS

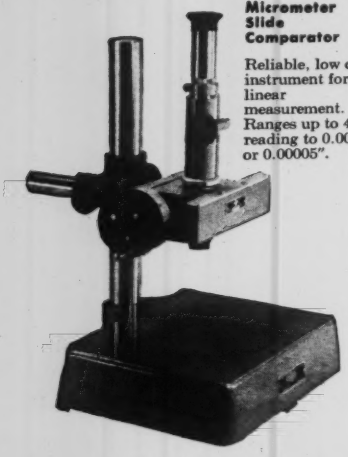
- Internal 1 megacycle crystal oscillator time base
- Accepts any external time base up to 1 megacycle
- Fast reset—recycles in 50 microseconds
- Independent and simultaneous outputs
- Preset counter up to 1 megacycle

For complete information, write or call

Potter POTTER INSTRUMENT COMPANY, INC.

115 Cutter Mill Road, Great Neck, N. Y.

For more information circle **102** on inquiry card.



Micrometer Slide Comparator

Reliable, low cost instrument for linear measurement. Ranges up to 4", reading to 0.0001" or 0.00005".

Gaertner measuring microscopes

Easy, sure measurement to 0.0001" cuts rejects and speeds production

Precise, versatile, easy-to-use Gaertner measuring microscopes assure positive, direct measurement of precision parts. You see clear, sharply-defined images. No physical contact to distort or injure object being measured. Enjoy new production savings with Gaertner optical instrumentation. Write for complete data on the Gaertner line of industrial microscopes.

Toolmakers' Microscope

Ultimate in measuring microscopes. Range 2" x 4", reading to 0.0001", angular measurement to 1 minute.

Coordinate Measuring Microscope

High precision, low cost instrument for 2-dimensional linear measurement. Range 2" x 2", reading to 0.0001".

Filar Micrometer Microscope

High quality, low cost instrument for extremely precise measurements. Range 0.08", reading to 0.00002".

Write for Bulletin 161-54 showing applications, models, specifications.

The Gaertner Scientific Corporation

1211 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

For more information circle **103** on inquiry card.

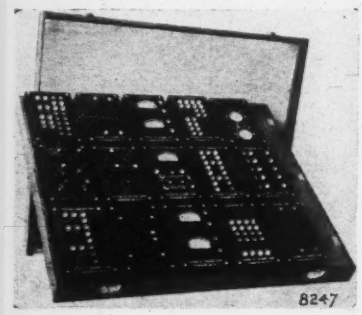
NEW INSTRUMENTS

test applications. Controls provide excellent resolution, utilizing multiple-decade ranges for pulse spacing, delay, and width. Rep rates from 10 cps to 100 kc; variable advance or delay operation 0-100 usec; variable pulse width 0.1-100 usec; variable-amplitude low-impedance output.—*Electro-Pulse, Inc.*, 11861 *Teale St., Culver City, Calif.*

For more information circle **264** on inquiry card.

SUBASSEMBLIES AND TEST INSTRUMENTS

New "Instant Circuits" for transistor circuit design comprise a number of individual units, each a basic cir-

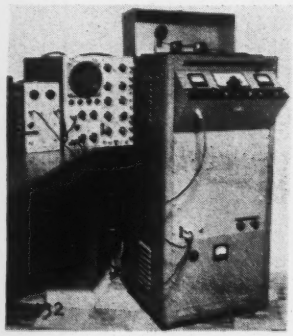


cuit element, signal source or test instrument. Basic kit of fifteen units permits general circuit synthesis and testing in audio range. High-frequency units can be added to extend range. —*Dept. IC, Instant Circuits Div., Alfred W. Barber Labs., 32-44 Francis Lewis Blvd., Flushing 58, N. Y.*

For more information circle **265** on inquiry card.

MINORITY CHARGE CARRIER LIFETIME TEST SET

New test set, for minority charge carrier lifetime of a semi-conductor material, comprises three units: a



test cabinet, a Tektronix "535" oscilloscope with a 53/54c dual beam plug-in unit, and a Tektronix "121" preamplifier. A trigger and two signals are supplied to 'scope from pulse generator and test specimen.—*Marvelco Electronics Div. National Aircraft Corp.*, 3411 *Tulare Ave., Burbank, Calif.*

For more information circle **266** on inquiry card.

NORTHAM

HIGH RANGE PRESSURE TRANSDUCER

A variable inductance instrument for the measurement of steady state and transient pressures in rocket and engine testing, hydraulics research, and other applications involving high pressure measurement and control. The pressure sensing diaphragm is integral with the body, providing high resistance to shock and vibration. There are no other moving elements. May be worked with non-corrosive liquids and gases.

MODEL GP-8 SPECIFICATIONS:

Pressure Ranges:.....0-200 to 0-5,000 psig
Maximum Allowable Pressure:...Twice rated pressure range
Accuracy:.....± 1% full scale
Excitation Frequency: From 60 to 20,000 cps
Natural Frequency: From 2,000 cps to 10,000 cps depending on range
Acceleration Response: Less than 1%/1,000 g along most sensitive axis (range above 1,000 psi)
Less than 1%/1,000 g axial (all ranges)

WRITE FOR BULLETIN NO. IA-8

Northam Engineering Facilities Are Available To Assist You With Any Application Problems.

NORTHAM PRODUCTS INCLUDE . . .
Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

NORTH AMERICAN INSTRUMENTS, INC.
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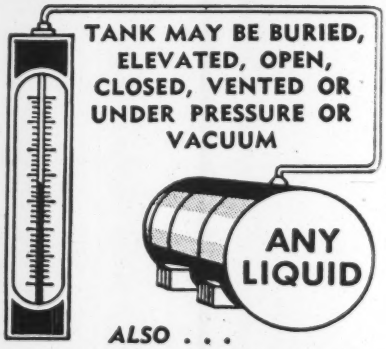
For more information circle **104** on inquiry card.

TANK-O-METER

FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY



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FOR ALL PURPOSES

PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
DIFFERENTIAL PRESSURE
MERCURIAL BAROMETERS

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470 GETTY AVE., PATERSON, N. J.

For more information circle **105** on inquiry card.

ELECTRICAL and ELECTRONIC INSTRUMENTS

DIGITAL OHMMETER

New "Modification L" of completely automatic digital ohmmeter has ten times greater sensitivity than former

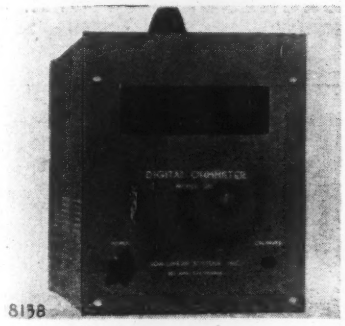
7927

models. Accuracy within 0.01% ± 1 digit from 0.01 ohm to 0.1 megohm with ranges to 10 megohms at reduced accuracy. Automatically-positioned decimal point and ohm or kilohm symbol in extreme right window. —*Electro Instruments, Inc., 3794 Rosecrans St., San Diego, Calif.*

For more information circle **267** on inquiry card.

DIGITAL OHMETER

New "Model 751" digital ohmmeter, designed especially for industrial applications, has oil-sealed stepping



8138

switches for long, trouble-free life; automatically-shifting decimal point, and automatically-varied resistance symbols. Range zero to 9.999 megohms; minimum resolution 10 ohms. —*Non-Linear Systems Inc., Del Mar Airport, Del Mar, Calif.*

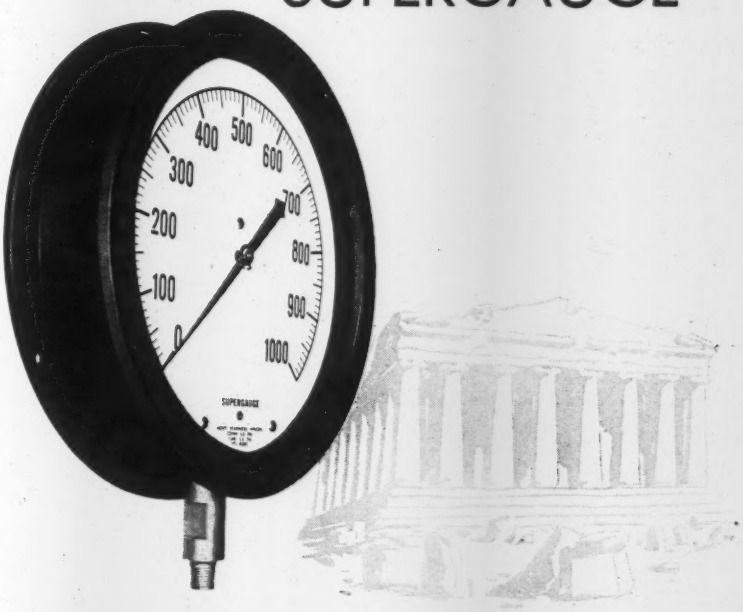
For more information circle **268** on inquiry card.

DIGITAL AC RATIOMETER

New 5-digit ac ratiometer supplements previously-announced dc type; automatically measures and displays

8112

the NEW USG SUPERGAUGE®



...built to last a lifetime!

With proper application, the new USG Supergauge will last a lifetime!

SEGMENT—stainless steel, with nylon-faced gear section. Nylon-to-metal bond stabilizes the nylon against expansion and contraction . . . maintains accurate pitch diameter . . . assures proper mesh with stainless steel pinion under severe temperature and moisture conditions.

MONO-UNIT CONSTRUCTION—permits easy removal of complete gauge assembly for inspection and adjustment.

ARC-LOC MOVEMENT—permits all calibration adjustments of gauge assembly from rear without removing dial and pointer.

LEGEND ON DIAL—gives complete description of socket, Bourdon tube and movement material for ready identification.

MICROMETER ADJUSTABLE SELF-LOCKING POINTER—permits accurate repositioning of pointer.

These features are also available in USG Solfrunt Gauges with solid front construction.

Supergauges available in 4½", 6", and 8½" sizes. For complete information on case styles, materials of construction and connections write for Publication 1819.

UNITED STATES GAUGE

Division of American Machine and Metals, Inc.

Sellersville, Pa.

Home of the **SUPERGAUGE**

For more information circle **106** on inquiry card.

CROW ELECTRI-KITS

. . . the quickest route to a practical mastery of electricity and electronics

HERE'S WHY

● Crow Electri-Kits are tailored to individual needs—from Basic Electricity to specialized courses in Advanced Electronics. You start at your own proficiency level and progress as far and as fast *as you want*.

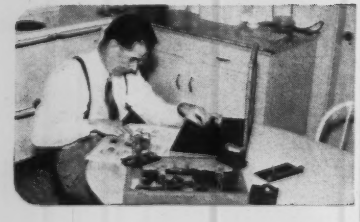
● Crow Electri-Kits can be used by students with little or no mathematical background. You learn by performing actual experiments that illustrate electrical principles and their applications. Instead of a maze of mathematical formulas, electricity becomes an exciting adventure in learning.

● Crow Electri-Kits are *complete*. You get all parts needed for every experiment PLUS a fully illustrated manual that gives step-by-step directions for assembly, historical background, and practical applications of the theory involved.

● Crow Electri-Kits have revolutionized the study of electricity and electronics in thousands of school shops, armed forces schools and plant training programs. "Exactly what I've looked for for many years," says one user. Get full details and see if you don't agree.

FOR ON-THE-JOB TRAINING PROGRAMS

OR SELF-INSTRUCTION AT HOME



CROW ELECTRI-CRAFT CORPORATION

Division of Universal Scientific Co., Inc. | BOX 336W, VINCENNES, INDIANA

For more information circle **107** on inquiry card.

NEW INSTRUMENTS

ratio of two alternating voltages without phase shift error. In operation, alternating voltages are converted to dc and direct voltages are presented. Ratio range 0.000 to 1.0999; readout time 1 second.—*Electro Instruments, Inc.*, 3794 *Rosecrans St., San Diego* 10, *Calif.*

For more information circle **269** on inquiry card.

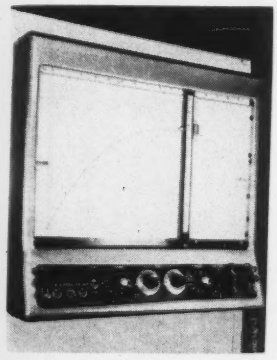
DIGITAL VOLT-OHMMETER

New "Model 352," designed especially for industrial uses and available in portable and rack-mount models, covers 0.01 to 999 vac, 0.001 to 999 vdc, and 1 ohm to 99.9 megohms; can be read from 30 ft or more, from straight-on or at angles; enables non-technical personnel to make measurements quickly with lab accuracy. —*Non-Linear Systems Inc., Del Mar Airport, Del Mar, Calif.*

For more information circle **270** on inquiry card.

X-Y RECORDER

New "Model 4 Autograf," for rack mounting, incorporates new special features in addition to those found on Models 1, 2, and 3. It accommodates either 11x16½" or 8½"x11" standard graph paper on an illuminated translucent table equipped with a self-contained vacuum hold-down system. Stepless range controls in addition to full range zero set and one scale length of zero suppression on each axis. Three step input filters on each axis permit smooth plotting of unfiltered signals.—*F. L. Moseley Co.*, 409 *N. Fair Oaks Ave., Pasadena, Calif.*



For more information circle **271** on inquiry card.

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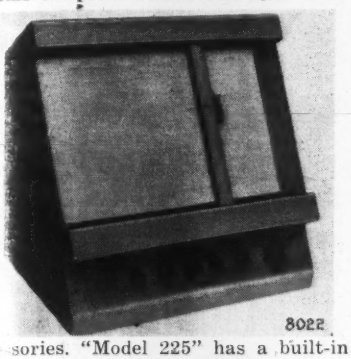
For more information circle **109** on inquiry card.

X-Y RECORDERS

Two new *X-Y* Recorders and Plotters, both 11" x 17" flat-bed models, come complete with a full line of ac-

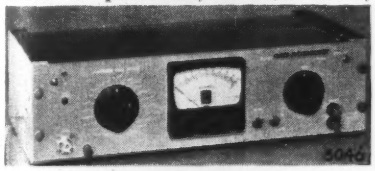


cessories. "Model 225" has a built-in electronic reference with 16 ranges from 0.5 mv to 50 v per inch on both axes. "Model 200" 9.1 to 20 v per inch (16 ranges), designed for either external ±100 v or internal reference for applications in high-speed analog recording and data plotting. Accuracy of both models is 0.2%. Both are said to "possess design features found on no other recorders, which increase operator convenience and reduce maintenance."—*Electro Instruments, Inc.*, 3794 *Rosecrans St., San Diego* 10, *Calif.*

For more information circle **272** on inquiry card.

MICRO-MICROAMMETER

New "Model 410" is well suited to measure, record, or control low currents in photocells, semiconductors,

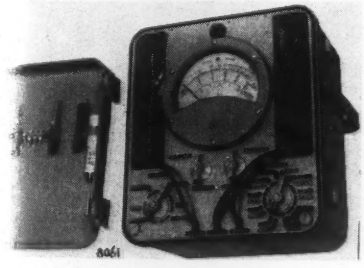


ion chambers, etc.; also for liquid level control, etc. (with proper pickups). Twenty ranges, from 10^{-3} to 3×10^{-13} amp full-scale. Accuracy 3% or better; zero drift less than 2% of full-scale after 5-min warmup, with less than 2% in any subsequent 24-hour period.—*Keithley Instruments, Inc.*, 12415 *Euclid Ave., Cleveland* 6, *Ohio.*

For more information circle **273** on inquiry card.

VOLT-OHMMETER

New "Model NE No. 7-20-M Electronic Multimeter" is identical to "Military Model TS-505B/U" for



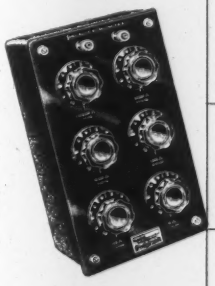
DECADE RESISTANCES & VOLTAGE DIVIDERS

delivered from stock

Accuracy: 10 ohms and above: ±0.1%
1 ohm: ±0.25%
0.1 ohm: ±1%
0.01 ohm: ±5%

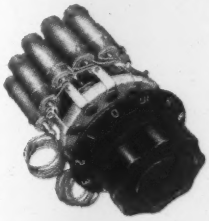
Temp. Coeff.: ±0.002% per degree C.
Maximum Load: ½-watt per step
Frequency Limit: Non-inductive to 20KC

DECADE RESISTANCE BOXES



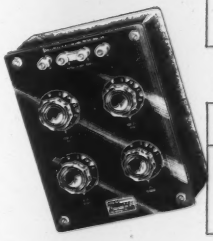
Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
817	3	0.01	11.1	$60.00
818	3	0.1	111	51.00
820	3	1	1,110	56.00
821	3	10	11,100	60.00
822	3	100	111,000	63.00
823	3	1,000	1,110,000	77.00
824	3	10,000	11,100,000	120.00
817-A	4	0.01	111.1	75.00
819	4	0.1	1,111	71.00
825	4	1	11,110	77.00
826	4	10	111,100	79.00
827	4	100	1,111,000	92.00
828	4	1,000	11,110,000	139.00
8285	5	0.1	11,111	94.00
829	5	1	111,110	101.00
830	5	10	1,111,100	113.00
831	5	100	11,111,000	155.00
817-C	6	0.01	11,111.1	105.00
8315	6	0.1	111,111	109.00
832	6	1	1,111,110	121.00
833	6	10	11,111,100	169.00

UNMOUNTED DECADE RESISTANCES



Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
435	1	0.1	1	$12.00
436	1	1	10	13.25
437	1	10	100	13.25
438	1	100	1,000	15.00
439	1	1,000	10,000	16.00
440	1	10,000	100,000	18.50
441	1	100,000	1,000,000	32.50
442	1	1,000,000	10,000,000	60.00

DECADE VOLTAGE DIVIDERS (Potentiometers)



Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
845	3	1	1,000	98.00
837	4	0.1	1,000	126.00
835	4	1	10,000	132.00
836	4	10	100,000	146.00

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Shallcross

For more information circle **110** on inquiry card.

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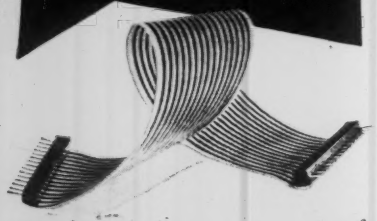

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By means of an exclusive Sanders process, the versatile plastic Kel-F can now be laminated with copper in thin sheets to provide a flexible printed circuit cable. This unique development introduces an entirely new concept in the fabrication of multi-conductor cables or wiring harnesses. Excellent electrical and mechanical properties are supplied for operation over a wide range of environmental conditions. The complete encapsulation of the conductors in Kel-F ensures maximum protection against moisture. Glass cloth can also be included in the laminations for increased strength and high temperature stability.

FEATURES

- **Excellent dielectric strength**
- **High degree of flexibility**
- **Lighter, thinner than many cables**
- **Maximum environmental protection**
- **Adaptable to many connectors**
- **Multi-layer construction available**
- **Suitable for chassis harnesses**
- **Wiring errors are eliminated**
- **Easily mounted**

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SANDERS ASSOCIATES INCORPORATED
NASHUA NEW HAMPSHIRE

For more information circle **111** on inquiry card.

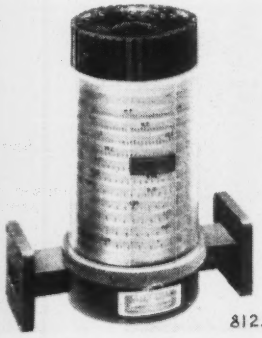
NEW INSTRUMENTS

measuring rms values of ac voltages from 0 to 150, dc voltages from 0 to 1000 and dc resistance from 0 to 1000 megohms. An RF adapter extends range to 40 rms at frequencies up to 500 Mc. Over-all accuracy 4% in ohms, 5% in dc volts and 6% in ac volts. Added feature enables user to quickly check polarity of dc voltages or for zero voltage.—*Northeastern Engineering, Inc., Manchester, N. H.*

For more information circle **274** on inquiry card.

X-BAND FREQUENCY METER

New "Model X532A," first of a new series of wideband direct-reading waveguide frequency meters, provides

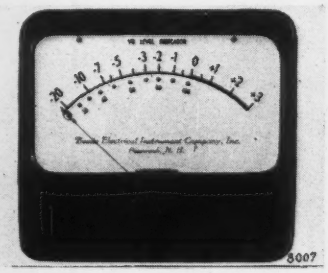


direct reading measurements from 8.2 to 12.4 kMc. Accuracy 0.8%; resetability 0.01%, backlash 0.005%. Effective length of spiral scale about 77", with calibration in 5-Mc increments.—*Hewlett-Packard Co., 275 Page Mill Road, Palo Alto, Calif.*

For more information circle **275** on inquiry card.

VU LEVEL INDICATORS

New models of maker's "VU Meters" are built into specially-styled cases, in clear Model #23 plastic or



satin black Model #16; conform to ASA and JAN specs. Zero power level 1 mw in 600-ohm line.—*Beede Electrical Instrument Co., Inc., Penacook, N. H.*

For more information circle **276** on inquiry card.

LIGHT SPOT WATTMETER

New "Model GLM" (made by Hartmann & Braun AG, Frankfurt on Main) features 0.1% accuracy of indication for dc and ac; and "con-

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For more information circle **112** on inquiry card.

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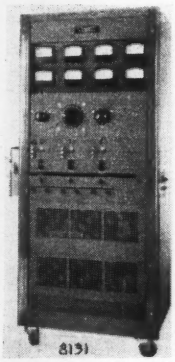
For more information circle **113** on inquiry card.

stancy of calibration is guaranteed." Shielded electrodynamic measuring system is "insensitive to strong external fields." Available in ranges from 25 ma to 10 amp and from 30 to 300 v.—*Epic, Inc.*, 154 *Nassau St., New York* 38, *N. Y.*

For more information circle **277** on inquiry card.

POWER SUPPLIES

MULTIPLE-OUTPUT SUPPLY



New "Model M224" produces three independent regulated voltages. No. 1: 0 to 5.5 kvdc negative with respect to ground at 0.5 amp; regulation and ripple 0.05%; drift less than 0.05% per day. No. 2: 0 to 1500 vdc negative with respect to output No. 1 at ± 50 ma; regulation, ripple and drift same as for No. 1. No. 3: 0 to 2000 vdc positive with respect to output No. 1 at 10 ma; regulation, ripple and drift same as for No. 1. Load is protected against arcs in each supply and outputs are protection-interlocked among themselves.—*Manson Labs., Dept.* 207 *Greenwich Ave., Stamford, Conn.*

For more information circle **278** on inquiry card.

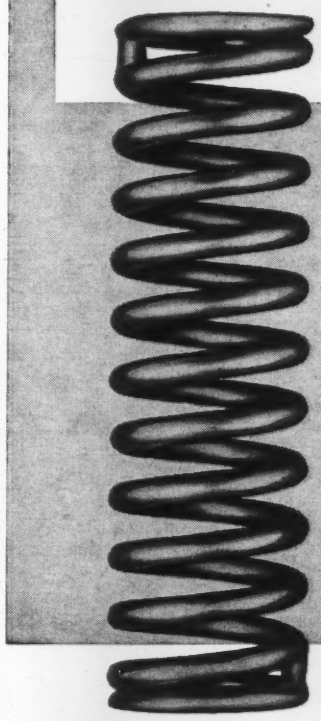
16-KV POWER SUPPLY

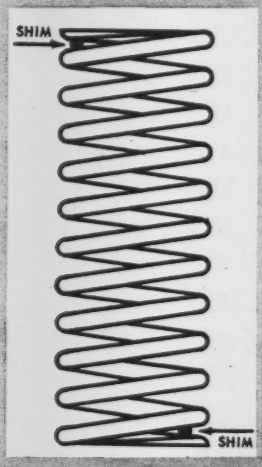
New completely electronic transistorized dc to dc power supply produces 16,000 v from as little as 3 v input; weighs 1½ lb. Units are also available that deliver 16 kv at as much as 200 ma from 12 v input where more current is desired; that give any practical combination of voltage and current up

it's the shim that counts in

CHATILLON COMPRESSION SPRINGS

Available in practically all sizes and capacities





Chatillon's compression springs with calibrated shims—an original Chatillon development—perform so accurately, they are specified in the precision instruments of leading manufacturers: e.g.: General Electric (ordnance equipment), Bendix (pressure transmitters), Chandler-Evans (aircraft carburetors). Shims brazed on the end coils of this spring maintain constant number of active coils during compression, thereby insuring constant rate. Straight line relationship between load and deflection is considerably improved. This great increase in accuracy, costs no more! Chatillon compression springs are available in Iso-Elastic* (Chatillon's own temperature-compensated alloy) or other spring alloys. Chatillon also manufactures Spiral, Torsion and Form Springs in Iso-Elastic and conventional alloys.

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For more information circle **114** on inquiry card.

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ENGELHARD INDUSTRIES

For more information circle **115** on inquiry card.

to 50 watts; also custom-made units to 300 watts.—*Universal Atomics Corp., 19 E. 48th St., New York 17, N. Y.*

For more information circle **279** on inquiry card.

TRANSISTOR POWER SUPPLY

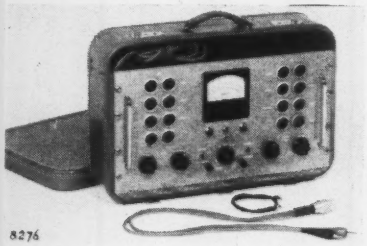
New "Hycon-Verter" transistor magnetic power supply is designed to replace small vibrators, inverters,

or dynamotors; has a 24 vdc input and provides outputs of 115 vac 400 cps, and 150 vdc, with a 25-watt load rating. Efficiencies as high as 90% —*Hycon Mfg. Co., 2961 E. Colorado St., Pasadena, Calif.*

For more information circle **280** on inquiry card.

CALIBRATION SUPPLY

New "Nabors Precision Calibrator" is a portable multi-range source of calibrated direct voltage and current

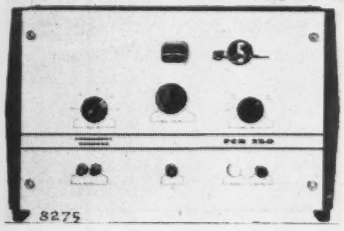


for checking dc indicating instruments with full protection on all instrument ranges; is suitable for unskilled operators. No warm-up.—*Thomas L. Stevens Co., 5333 S. Sepulveda Blvd., Culver City, Calif.*

For more information circle **281** on inquiry card.

FREQUENCY CHANGER

New "Model FCR 250" converts 50- or 60-cps line power to any desired frequency between 320 and 1000 cps;

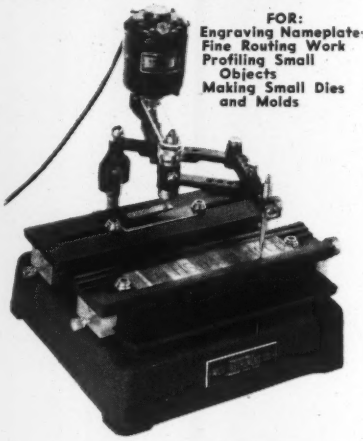


is designed to replace rotating equipment; provides frequency regulation within 1%. Regulation of 0.01% is available with auxiliary 400-cps frequency standard.—*Sorenson & Co., Inc., 375 Fairfield Ave., Stamford, Conn.*

For more information circle **282** on inquiry card.

MICO

New Heavy-Duty 2 & 3 Dimensional Engraver



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1. Six Reduction Ratios—From 1.5:1 to 4:1.
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4. Absolute accuracy for three-dimensional reproduction.
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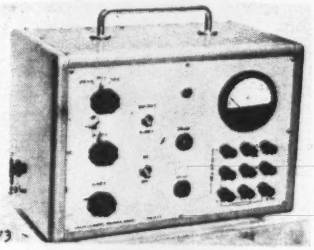
For more information circle **117** on inquiry card.

REGULATED POWER SUPPLY

New "Type LS-14" (made in Sweden) delivers 0 to 500 vdc continuously variable, 200 ma up to 400

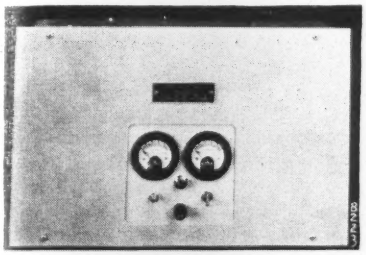


v Stabilization: 10-25 mv change in o tput for 10% change in line voltage; 0 -0.2 v change for no-load to full-l ad; ripple 0.5 mv rms at 200-ma f ll load.—*Oltronix*, 235 *Underwood D ive, Atlanta* 5, *Ga.*

For more information circle **283** on inquiry card.

REGULATED POWER SUPPLY

New "Model 910 Reactrol" derives its name from its saturable *reactor* c ntrol circuit of advanced design. In



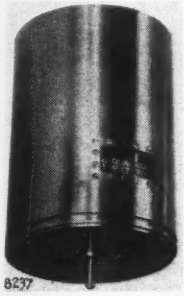
addition to excellent (0.2%) regulation of 28-vdc output for changes in load current and line voltage, units are also regulated against slow changes in frequency of input power source. Output current 10 amp. Unitized construction: additional filter sections can easily be added.—*Deltron Inc., P.O. Box* 192, *Glenside, Pa.*

For more information circle **284** on inquiry card.

ELECTRICAL COMPONENTS

DIGITAL VOLTAGE DIVIDERS

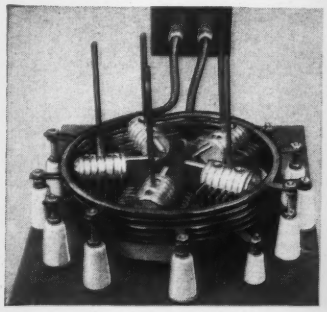
New "Models 302 and 303," in Baker's "Ratio-Tran Precision AC Voltage Divider" line, are sealed rotary shaft-driven units. "Model 302," 1000-turn, has a terminal linearity of 0.005%; "Model 303," 100-turn, terminal linearity 0.01%. Both have continuous transient-free output, low (30-ohm) output impedance, and extremely low phase



The Lepel line of Induction heating units represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating. With a background of half a century of electrical and metallurgical experience, the name Lepel has become the symbol for quality in induction heating equipment embodying the highest standards of engineering achievement, dependable low cost operation and safety.

If you are interested in the application of induction heating you are invited to send samples of the work with specifications of the operations to be performed. Our engineers will process these samples and return the completed job with full data and recommendations without any cost or obligation.

TYPICAL INDUCTION HEATING APPLICATIONS

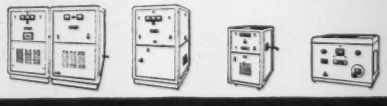


The illustration shows a lens grinding block being heated within the dome-shaped work coil. The heat generated in the metal block softens the pitch enabling the operator to remove the ground lenses and insert the next batch. The entire operation is completed in a few seconds.

A widely used application in which several assemblies, consisting of a brass body, six radiator fins and a mounting stud, are being soldered simultaneously. The production of similar parts can be further increased by using two work coils and a change-over switch.

Electronic Tube Generators—1 KW; 2½KW; 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.
Spark Gap Converters 2 KW; 4 KW; 7½ KW; 15 KW; 30 KW.

WRITE FOR THE NEW LEPEL CATALOG . . . 36 illustrated pages packed with valuable information.



All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

LEPEL HIGH FREQUENCY LABORATORIES, INC.
55th STREET and 37th AVENUE, WOODSIDE 77, NEW YORK CITY, N. Y.

For more information circle **118** on inquiry card.

T-E's new "Ceramo" wire handles the jobs too tough for ordinary thermocouple wires. "Ceramo's" construction — thermocouple-material conductors and ceramic or inert metal oxide insulation encased in seamless metal sheathing — results in a thermocouple that, for a given application, will last longer and respond faster than conventional types. "Ceramo's" extra small diameters and unusual flexibility permit access to hard-to-get-at spots. You can bend it on a radius as small as its own diameter — with no short-circuiting or grounding. And "Ceramo" can be used bare where protection tubes would often be needed — will withstand pressures up to 40,000 psi! It also has excellent resistance to high temperature, moisture, chemicals, petroleum products, atomic radiation, and abrasion.

"Ceramo" *Thermocouple Wires* made in Iron-Constantan, Copper-Constantan, Chromel-Alumel, Chromel-Constantan and Platinum Rhodium-Platinum from 36 to 16 gage. Sheathing: Stainless Steels, Inconel, aluminum or copper. Overall diameters: 1/25" to ¼".

"Ceramo" *Thermocouple Extension Wires* made in Iron-Constantan, Chromel-Alumel or Copper-Constantan of 20 and 16 gage. Sheathing: copper-nickel alloy, plain or galvanized cold-drawn steel. Overall diameter: ⅛" and ¼".

Learn more about this versatile wire.
Write for bulletin 31-300-F.

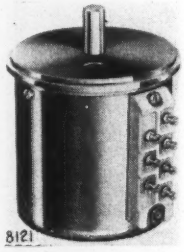
Thermo Electric Co., Inc.
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

For more information circle **119** on inquiry card.

shift. Input impedance of "303" is about 50 henrys, and of "302" about 200 henrys.—*Gertsch Products, Inc.*, 11846 *Mississippi Ave., Los Angeles, Calif.*

For more information circle **285** on inquiry card.

PRECISION VDR



New "S 7700" voltage-dividing resistor is a 10-turn 1⅛" dia. unit for servo or 3-hole pilot mounting. Choice of air-core winding with total resistance range from 200 to 5,000 ohms, or copper-mandrel winding from 5,000 to 200,000 ohms. In air-core windings, winding process corrects for errors in unit resistivity of wire and for mechanical-tolerance deviations in drum. Also, air-core wound units have less than 0.1° phase shift in ac circuitry.—*Helipot Corp., Newport Beach, Calif.*

For more information circle **286** on inquiry card.

TRIMMING VDR

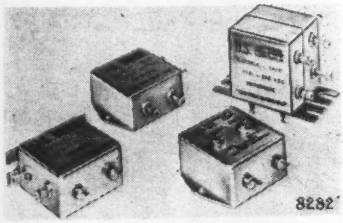
New "Trimpot Model 207 Hi-R" high-resistance (100k) unit features 2-watt dissipation, 175°C operation

and a precision wire-wound element with low temperature coefficient resistance wire; is screwdriver adjusted over 25 turns; has self-locking shaft; meets or exceeds most government specs.—*Bourns Laboratories*, 6135 *Magnolia Ave., Riverside, Calif.*

For more information circle **287** on inquiry card.

TRIMMER CAPACITORS

New "Edcor Model B trim-adjustable precision polysterene capacitors feature variety of integral bracket



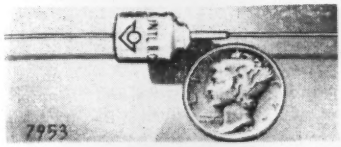
styles to meet every mounting requirement; can be trim-matched to ±0.01% with adjustment range to ±2½% of rated capacitance. Drift is less than 0.05% per year; temperature coefficient −50 ppm/C°; insulation resistance 2 meg meg/mfd.—*U. S. Electronics Development Corp.* 1323 *Airway, Glendale* 1, *Calif.*

For more information circle **288** on inquiry card.

ELECTRONIC COMPONENTS

1000-VOLT SILICON DIODE

New 1000-v diode is one of a series of high-voltage silicon diodes now available in production quantities, in

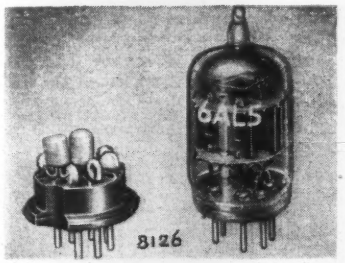


peak inverse voltage classifications of 600 v, 800 v and 1,000 v, with half-wave dc output currents of 125 ma at 75°C ambient. Operating temperature range −55° to 150°C ambient.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **289** on inquiry card.

PLUG-IN DUAL DIODES

New "Type 60-7788" (left) plug-in selenium rectifier, especially designed to replace "6AL5" tube (right) in

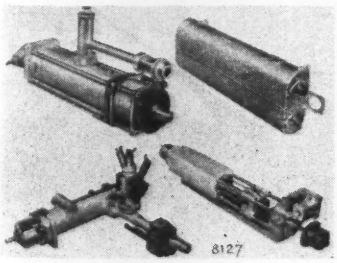


many sync discriminator circuits, offers advantages of much smaller size, no heater power, higher reliability factor. It consists of two "1U1" selenium diodes mounted and soldered to a plug that fits a 7-pin miniature tube socket. Each diode is designed to deliver 20 vdc at 1.5 ma for 26v rms maximum input.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **290** on inquiry card.

MICROWAVE AND UHF COMPONENTS

New "custom-line" of microwave and UHF components includes standard as well as job-engineered complex units. Illustrated: Top left—Tunable S-band transmitter cavity, re-entrant type, pulse output 150 w. Top right—Tunable UHF coaxial resonator that operates at relatively low frequencies



For more information circle **121** on inquiry card.

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DIRECTOR OF PERSONNEL
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RESEARCH AND ENGINEERING DIVISION
BOX 8, STATION B, DAYTON 7, OHIO

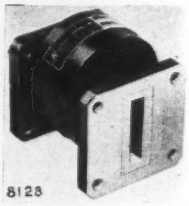
VISIT

THIRD INTERNATIONAL AUTOMATION EXPOSITION
NEW YORK TRADE SHOW BUILDING
NOVEMBER 27-30, 1956 BOOTH 624

with extreme selectivity and extremely high signal-to-noise ratio. Lower left—S-band signal generator cavity, re-entrant type, frequency range 2700 to 3400 Mc, complete with thermistor mount and calibrated variable attenuator. Lower right—Coaxial-type cavity, tunable from 500 to 1050 Mc, 0.01% frequency calibration accuracy. —*J-V-M Engineering Co., Dept. IUP, 4633 S. Lawndale, Lyons, Illinois.*

For more information circle **291** on inquiry card.

FERRITE ISOLATOR

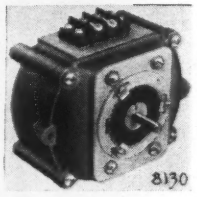


New "Model W 165-2B Low Power Displacement Absorbtion Ferrite Isolator" differs in physical and electrical characteristics from recently-announced "W 165-1A"; has a 1000-Mc bandwidth (8.5 to 9.5 kMc); db ratio of isolation to insertion loss 50 to 1; will handle 50 kw peak power 50 watts average; vswr less than 1.40. —*Kearfott Co., Western Div., 253 No. Vinedo Ave., Pasadena, Calif.*

For more information circle **292** on inquiry card.

ELECTROMECHANICAL COMPONENTS

ROTARY SOLENOID

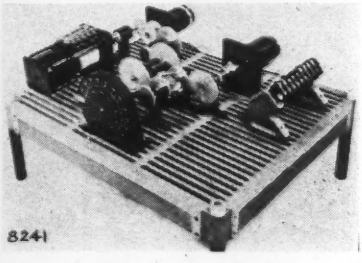


New model of maker's "800 Series A. C. Rotary Solenoid" features built-in return springs permitting direct application; obviates need for remote springs and extra assemblies to return load to starting position after solenoid work stroke is completed. Wide selection of springs; and design of special springs having higher potential gradient.—*Dept. 34, Leetronics, Inc., 30 Main St., Brooklyn, N. Y.*

For more information circle **293** on inquiry card.

BREADBOARD COMPONENTS

New "Beckman" electromechanical breadboard parts line (recently acquired from Belock Instrument Corp.)

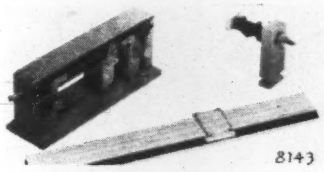


features extremely close tolerances. Among components: grid plates, shaft hangers, component hangers, shaft hardware, shafting, electric and electromechanical limit stops, gears and differentials, magnetic clutches and ball-and-disc integrators.—*Helipot Corp., Newport Beach, Calif.*

For more information circle **294** on inquiry card.

LIMIT STOPS

New limit stops halt shaft rotation by purely mechanical means or use switches to cut power at appropriate



moment. Three basic types: "Wafer Limit Stop"; "Lead Screw Mechanical Stop" available in three models; "Lead Screw Electromechanical Stop" with double scale calibrated in number of turns for each direction.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.*

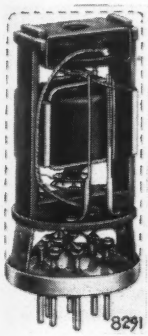
For more information circle **295** on inquiry card.

SUPERSENSITIVE RELAY

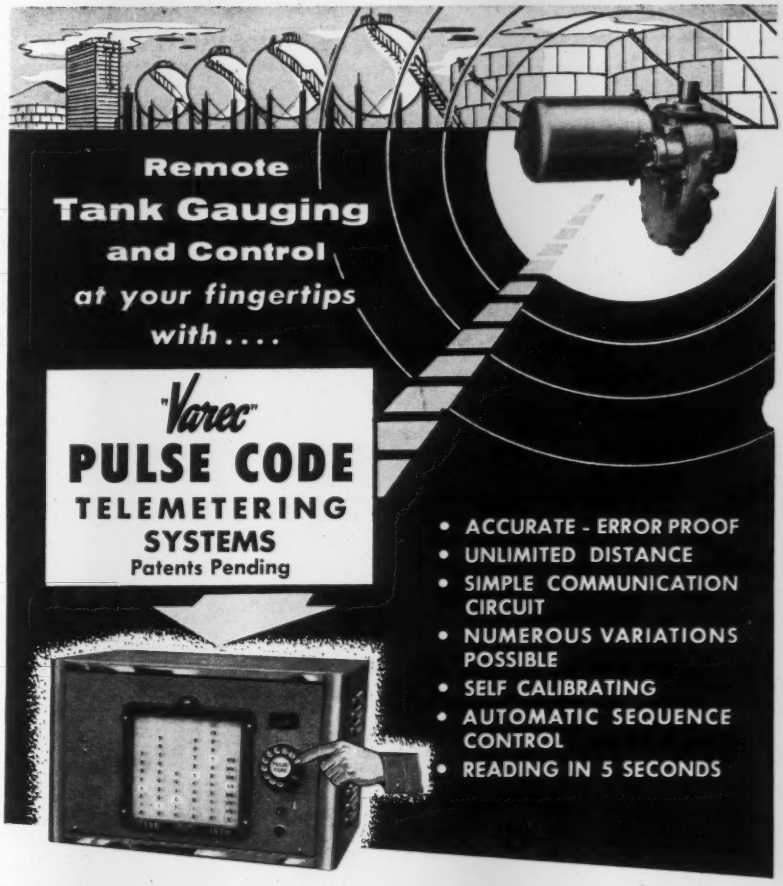
Newly modified "Model 266 VHS" (very-high-sensitivity) relay now meets MIL specs: shock and vibration and ambient temperatures of −55°F to 150°F. Torque and contact spacing have been increased. Sensitivities from 0.2 ua to 10 amp or 0.1 mv to 500 v. Ac relays have built-in silicon or germanium diodes, or copper oxide rectifiers. Contact ratings from 5 to 125 madc. Moving element, similar to voltmeter or microammeter, rotates on polished pivots in sapphire jewels.—*Assembly Products, Inc., Desert Hot Springs, Calif.*

For more information circle **296** on inquiry card.

MINIATURE SEALED RELAY



New "Model 1081," for relay applications where compactness and light weight are essential, or where external electromagnetic effects must be minimized, is supplied for miniature 7 pin socket operation or with curved terminals for solder connection. Tinned-finished brass case (for maximum shielding Mu-metal cases can be furnished). Ranges and



Pioneers in the remote gauging field, "Varec" has researched the various possible types of remote gauging, and developed a system that offers an unusual combination of advantages for the user. "Varec" PULSE CODE uses a distinct code combination of dots and dashes for each signal to insure accurate reading; the possibility of error resulting from a miscount of pulses, as in a "pulse-count" system is avoided. If the communications channel is capable of carrying any other type of information accurately, it will handle Pulse Code signals without error, or else give no signal. Reliable readings to the nearest 1/8 inch. The system can be operated over all types of communication channels, including micro-wave.

You dial for desired information, then through the use of interlock circuits, the instrument takes over, **to give you a fast reading in 5 seconds.**

Power failure or line trouble will not cause loss of calibration. Normal operation will return on restoration of power. The equipment is rugged and reliable. Vacuum tubes are not used in the measuring circuit.

Great flexibility is assured by the "building-block" design. Special installations can be constructed with standard units — unlimited variations possible. Can provide, with appropriate equipment, a means for remote control of pumps, valves, high-low alarms and similar operating equipment.

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For more information circle **123** on inquiry card.

Torque as low as 0.003 ounce inches achieved by Giannini in MICROTORQUE® and MINITORQUE® Precision Potentiometers

For extremely sensitive instrument applications where minimum torque is essential, specify Giannini Microtorque and Minitorque precision potentiometers. Highly reliable performance under the most rugged operating conditions is assured by Giannini's care for detail and production crafting.

By using sapphire jewel bearings . . . and precision ball bearings in certain Minitorque models, these 1 inch diameter instruments effect an unusually low coefficient of friction.

Available in 12 standard linear wiring types, the potentiometer output can, on special order, be designed to perform to a wide range of natural or empirical functions. All models employ non-corrosive precious metal windings and contacts . . . thereby permitting light brush pressures and ensuring long noise-free life.

Dependability, reliability, and ten years proven application success are your benefits, when you use Giannini Microtorque and Minitorque potentiometers—precision instruments "crafted with care."

For additional information, please write for Bulletins 85111 and 85151.

SPECIFICATIONS:

Torque	0.003 to 0.008 oz. in. depending on resistance and wiring type. (Sleeve bushing Minitorque 0.025 oz. in.)
Resistance Range	100 to 100,000 ohms.
Linearity	±0.5% (±0.25% on special order)
Power Rating	1.63 watts @ 25°C.
Shaft Diameter	Microtorque, 0.031 in., Minitorque, 0.125 in.

Giannini

G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIFORNIA

For more information circle **124** on inquiry card.

NEW INSTRUMENTS

contact adjustments to order. Sensitivities as high as 50-0-50 microamperes at a coil resistance of about 2300 ohms. Non-magnetic contacts carry 35 ma at 6 vdc non-inductive at high sensitivity; loads up to 0.5 amp at 28 vdc non-inductive can be handled depending upon moving-coil sensitivity and number of operations. High and low contacts can be arranged for zero center, sp-dt operation or suppressed zero with one contact normally closed—*Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.*

For more information circle **297** on inquiry card.

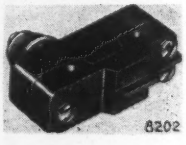
MACHINE TOOL RELAY

New 6-pole in-line 10-amp relay (NEMA Type A1B), designed for applications such as machine tools and control panels, increases flexibility and conserves panel space by reducing number of extra relays necessary in automatic control systems. New saddle-type terminal permits wiring from four directions with either plain wire or crimped-on terminal connections. New relay is available in both standard and latched-in forms, in 2-, 3-, 4- and 6-pole models, all voltages and frequencies to 600 v and 60 cps. All terminals are accessible from front. Other features designed to help cut installation cost by simplified wiring are captive clamps and large pan-head screws on terminals. More strength for terminals is provided by a new molding for stationary contact block.—*General Purpose Control Dept., General Electric Co., Schenectady 5, N. Y.*

For more information circle **298** on inquiry card.

SWITCHES

SPLIT-CONTACT SWITCH

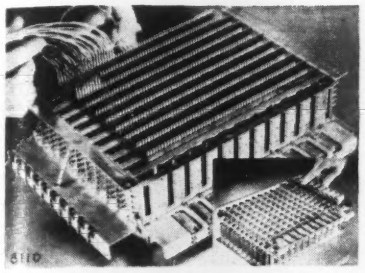

8202

New "Model C-11008" snap-action split-contact switch features high capacity (up to ¾ hp); dual circuitry; five terminals; and maker's rolling-spring snap-action principle. It is a normally-closed switch, but double-throw arrangement can control two single-pole throw circuits, or can be used for double make or break in a single circuit.—*Acro Mfg. Co., Columbus 16, Ohio.*

For more information circle **299** on inquiry card.

CROSSBAR SWITCH

New "Type F" crossbar switch, available in a number of matrix arrangements, offers simplified high-speed logic and a flexible high-speed means of selecting information remotely from a large number of sources (up to 1200 per switch) without necessity of scanning intermediate

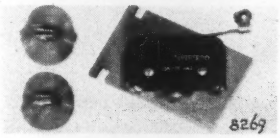


points; can be readily set up by means of punched cards, punched tape of telephone-type dials. Illustration shows the 600 individual crosspoint terminals in a 10x10x6 matrix. Top view (inset) shows select and hold magnets on two of switch's 3 co-ordinates. Taper tab connectors are shown being used on the terminals which are adaptable also for soldering or winding.—*James Cunningham, Son & Co., Inc., Rochester 8, N. Y.*

For more information circle **300** on inquiry card.

SWITCH ASSEMBLIES

New "Microswitch Unit" is a dp-st limit switch, rated at 10 amp for 24 to 30 vdc and 0.6 amp at 110 to 125



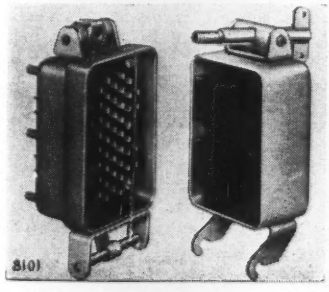
vac, mounted on a "Servoboard" component hanger; usable as either n-c or n-o. ★New "Cam Assembly" comprises a pair of cams used in conjunction with "Microswitch Unit" to open or close a circuit at a specific shaft position. After one cam has been locked to shaft, the other is set and locked for any dwell period from 0° to 360°. ★New "Pulse Disc" is used in conjunction with "Microswitch Unit" to open or close a circuit at a number of specific shaft positions; is provided with 36 tabs and their hardware.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **301** on inquiry card.

CONNECTORS

50-CONTACT CONNECTORS

New 50-contact plugs and receptacles, added to "115 Series," feature a vise-action screw lock mechanism



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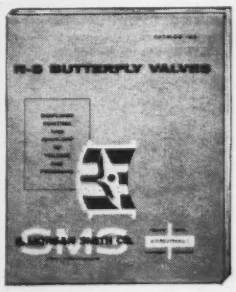

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For more information circle **125** on inquiry card.

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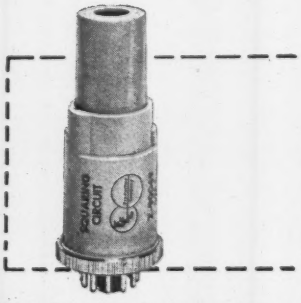
Plug-in Circuits

developed for EECO systems, provide a key to lower cost equipment design and fabrication. Data on standard and custom circuits available in catalog C-3



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For more information circle **126** on inquiry card.

NEW INSTRUMENTS

for maintaining positive mating under unusual physical stress; are rated 750 v rms 60 cps at sea level; are available with extended solder-cup contacts or taper-pin contacts.—*Amphenol Electronics Corp.*, 1830 S. 54*th Ave.*, *Chicago* 50, *Ill.*

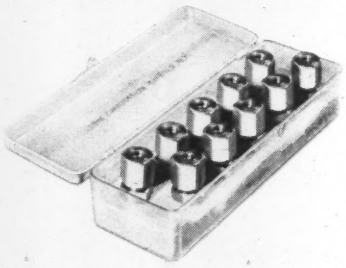
For more information circle **302** on inquiry card.

MECHANICAL COMPONENTS

PACKING GLANDS

New "Model MPG-AL" midget packing glands, machined entirely from 24S-T4 aluminum using "soft"

sealants, provide a simple, positive method of sealing wires, tubes or rods of any material. Normal bore diam-

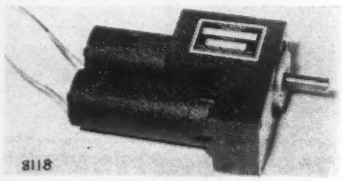


ters 1/16", 3/32", ⅛", and 3/16". Length 1⅛", ½" hex; temperature range −300°F to 1850°F; pressure range 500 to 7500 psi, depending on sealant.—*Conax Corp.*, 7811 *Sheridan Drive*, *Buffalo* 21, *N. Y.*

For more information circle **303** on inquiry card.

MINIATURE DIFFERENTIAL

New miniature differential is maker's gear reducer adapted as a mechanical differential device: internal



gear mounted freely, can be driven independently of input shaft, and resultant speed at output shaft is difference between speed of input shaft and speed of internal gear. Photo shows application in which a motor-driven planetary unit is used to drive internal gear of another MDP unit. Holding voltage constant on one unit and varying voltage on the other produces an output speed from 5 rpm in one direction, through zero, to 5 rpm in the other direction for loads up to 1000 oz-in.—*Globe Industries, Inc.*, 1784 *Stanley Ave.*, *Dayton* 4, *Ohio.*

For more information circle **304** on inquiry card.

DIGITAL READ-OUT FOR TEN-TURN COMPONENTS

New dial for digital read-out of rotor position is designed to simplify dial readings for multi-turn voltage-

dividing resistors; is suitable also for variable inductors, capacitors, etc.; comprises a three-digit counter (0 to 999) with provision for mounting on drive-shaft. —*Maxson Instruments Div., W. L. Maxson Corp.* 47-37 *Austell Place, Long Island City,* 1, *N. Y.*

For more information circle **305** on inquiry card.

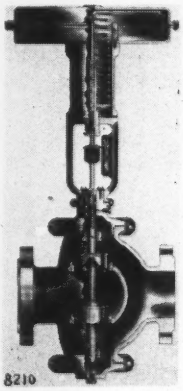
VALVES

SOLENOID VALVE

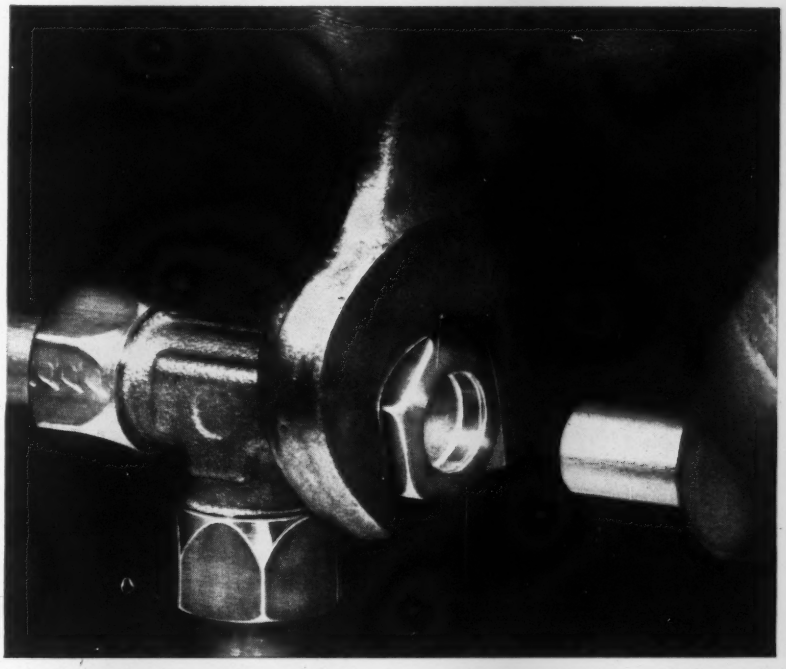
New "two-in-one" solenoid valve, designed for guided missile systems and adaptable to industrial automation, has a special dual operating feature: it can be operated from an "open" or "closed" position, conversion being made by a simple mechanical rearrangement of solenoid.—*Clary Corp., Dept. W*106, *San Gabriel, Calif.*

For more information circle **306** on inquiry card.

CONTROL VALVES



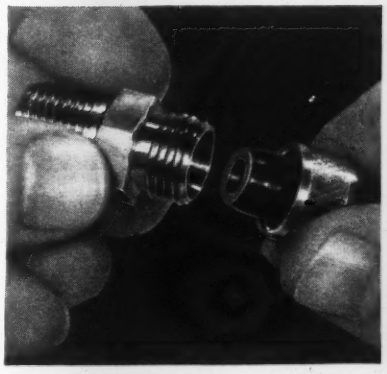
New "Super 70 Series" diaphragm control valves include: (1) new top-works with molded diaphragm for uniform thrust over full travel, pressed steel case and precision-calibrated single spring; (2) new valve bodies with streamlined flow contours, new top and bottom guided inner valves for more exacting flow characteristics; (3) new all-metal float ring seal which provides self-actuating closure and tightens with application



Simply push, then tighten! Anyone can quickly install all-new, *lightweight Intru-lok* tube fittings . . . the proven Parker 3-piece flareless design. Just insert the tube, then tighten the nut with a regular wrench . . . for a leakproof, vibration-proof joint. Made of brass for copper or nylon tubing. Send for complete details in Catalog 4324.

Introducing easy-to-use

PARKER INTRU-LOK



For soft plastic tubing you use knurled nut and expander insert with new *Intru-lok* body. Joints can be disconnected and reassembled. Complete details in Catalog 4324. Send for it.

Weld-lok fittings, for extreme temperatures, corrosion conditions . . . machined from high-quality steel or stainless bar stock and forgings . . . for tubing ¼" through 2" O.D.

TUBE AND HOSE FITTINGS DIVISION
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Parker
Hydraulic and fluid system components

For more information circle **128** on inquiry card.

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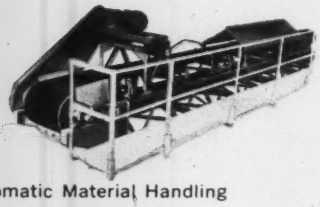
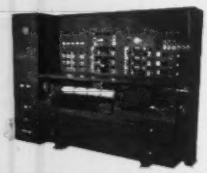


"a" Automatic Material Handling



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VISIT BOOTH 553, THIRD INT. AUTOMATION EXPOSITION, NOV. 26-30, 1956

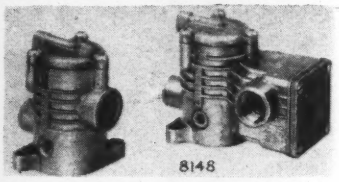
For more information circle **129** on inquiry card.

of pressure. Valve bodies available in three styles: single port, double port, and split body for use in erosive or corrosive fluid service where easy removability of valve seat is desirable.—*Black, Sivalls & Bryson, Inc., 7500 E. 12th St., Kansas City 26, Mo.*

For more information circle **307** on inquiry card.

SOLENOID PILOT VALVES

New line of small solenoid pilot valves, capable of handling air, vacuum, oil, water and inert gases, is com-

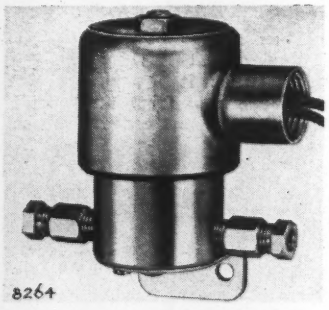


plete. Valves are available in 2- and 3-way types; are designed for control of "Speed King" remote-pilot-operated valves or direct control of small cylinders and similar devices. Capacities range up to 23.8 cfm air and 3.8 gpm hydraulic. Valves are said to be capable of controlling over 600 cycles per minute.—*Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.*

For more information circle **308** on inquiry card.

ELECTROPNEUMATIC VALVE

New electrically-operated air valve doesn't hum or chatter. Close tolerances prevent ac hum and other noise.



When energized, valve will pass full air at supply pressures up to 25 psi; when not energized, it will waste air from outlet port and close inlet. Manual adjustment permits valve to pass air when coil is not energized. Coil can be supplied for 60-cps voltages of 115, 208, 230, or 440.—*Powers Regulator Co., 3434 Oakton St., Skokie, Ill.*

For more information circle **309** on inquiry card.

PVC CHECK VALVE

New check valve made of polyvinyl chloride for handling corrosive fluids employs same unique principle used by maker in metal check valves; can be used in all PVC systems and installed in any position. Bodies are fabricated of tubing and flanges meeting ASA Standards. Internals are of PVC, with sealing members of

Transitron

SILICON VOLTAGE REGULATORS

	Type	Voltage Range (volts)	Maximum Average Current ma at 25°C	at 125°C	Maximum Dynamic Resistance (ohms)
TO 50 ma	SV-5	4.3 - 5.4	50	10	55
	SV-6	5.2 - 6.4	40	8	20
	SV-7	6.2 - 8.0	30	6	10
	SV-9	7.5 - 10.0	25	5	20
	SV-11	9.0 - 12.0	20	4	70
	SV-13	11.0 - 14.5	17	3.4	100
	SV-15	13.5 - 18.0	14	2.8	120
	SV-18	17.0 - 21.0	12	2.4	200

TO 150 ma	SV-804	4.3 - 5.4	150	30	55
	SV-805	5.2 - 6.4	120	24	20
	SV-806	6.2 - 8.0	90	18	10
	SV-808	7.5 - 10.0	75	15	20
	SV-810	9.0 - 12.0	60	12	70
	SV-812	11.0 - 14.5	50	10	100
	SV-815	13.5 - 18.0	40	8	120
	SV-818	17.0 - 21.0	35	7	200

			(amps)	(ma)	
TO 2 AMPS	SV-904	4.3 - 5.4	2.0	400	2
	SV-905	5.2 - 6.4	1.6	320	2
	SV-906	6.2 - 8.0	1.2	240	2
	SV-908	7.5 - 10.0	1.0	200	2
	SV-910	9.0 - 12.0	.8	160	2
	SV-912	11.0 - 14.5	.7	140	4
	SV-915	13.5 - 18.0	.6	120	6
	SV-918	17.0 - 21.0	.5	100	8

Transitron's silicon voltage regulators (sometimes called Zener diodes) are constant voltage elements for control and similiar circuitry. They provide excellent regulation and stability over a wide operating range.

Through improved thermal design, each of the three regulator series will give high load currents in the smallest possible size. The subminiature glass types, for example, provide twice the current in less than half the size of conventional regulators. High power types can be used to simplify circuits and eliminate amplification stages.

Inquiries are invited on higher voltage regulators, and precision, temperature compensated voltage reference elements.

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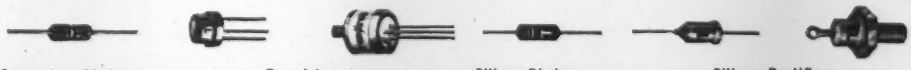
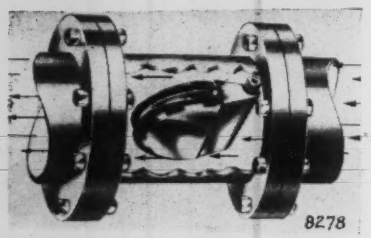


Germanium Diodes Transistors Silicon Diodes Silicon Rectifiers

For more information circle **130** on inquiry card.

NEW INSTRUMENTS



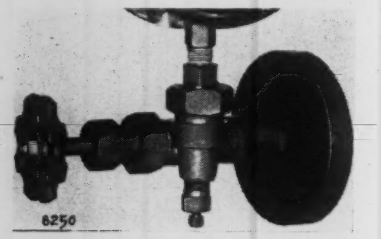
8278

plasticized PVC, neoprene, or Buna N, all reinforced with nylon for high strength. Hardware is of stainless steel. Sizes 1" to 8".—*Techno Corp., 16 W. 5th St., Erie, Pa.*

For more information circle **310** on inquiry card.

INSTRUMENT PIPING VALVE

New "66U-VG" valve for instrument piping and general use combines unions, nipples, reducers, elbows, tees, valve and drain valve into one space-saving unit. It is an offset valve with a vertical rising ball check on downstream side of seat and with a solid shank connection to vessel which makes it acceptable as a block or root valve, and makes it possible to eliminate usual block valve.—*Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.*



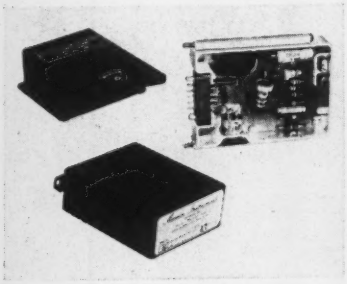
8250

For more information circle **311** on inquiry card.

FOR AIRCRAFT AND MISSILES

SERVO AMPLIFIERS

New subminiature servo amplifiers comprise transistor and vacuum-tube types. Transistor models include 1- and 3-watt units using silicon transistors capable of withstanding a wide range of environmental conditions; and 6- and 9- watt units using germanium transistors to provide high power output at low cost. These units, designed for use with 400-cps servomotors in airborne service, vary in weight from 4 to 5 oz. Other transistor amplifiers include resolver, summing, automatic gain control, preamplifier, and demodulator units. Vacuum-tube models include a 5-watt amplifier and a 4-oz precision summing amplifier that handles up to seven inputs at an accuracy of ±0.05% —*Maxson Instrument Div., W. L. Maxson Corp., 47-37 Austel Place, Long Island City 1, N. Y.*



For more information circle **312** on inquiry card.

ACCELERATION PICKUP

8116

New "Model DDL," developed specifically for transonic and supersonic guided missiles and aircraft flight control applications, is a variable-resistance-ratio dual-damped low-range (to ±8*G*) unit with unusually good resistance to severe vibration and shock accelerations. Dual damping is accomplished by use of a permanent magnet and a silicone fluid. Output is linear. Electrical noise is minimized by careful adjustment

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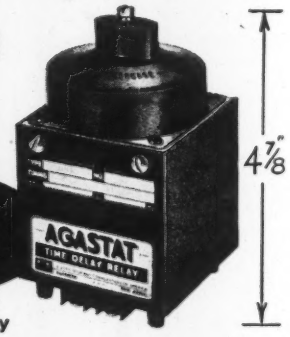

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When automatic machinery and circuits must be timed with repetitive accuracy (from 0.1 second to ten minutes or more) you'll find a sure, reliable answer in AGASTAT electrically-actuated pneumatically-timed time delay relays.

The AGASTAT is

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AGA DIVISION

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Pioneers in pneumatic timing.

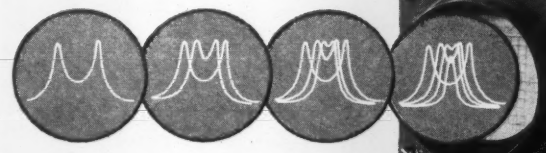
For more information circle **132** on inquiry card.

The Memo-Scope, incorporating the famous MEMOTRON, *combines the unique quality of information persistence with all the features of a superior quality laboratory oscilloscope.*

The Memo-Scope by Hughes is a storage oscilloscope that captures and retains any number of traces indefinitely at a constant intensity until intentionally erased. Traces are readily visible in a brightly-lighted room, and may be easily photographed.

NEW!

The only scope with a memory.



MEMO-SCOPE

Memo-Scope is available in two models: Portable (Model 103), and Rack Mounted (Model 103-R).

Plug-in vertical amplifiers of a variety of characteristics are available to increase flexibility. Hinged camera mount swings photographic apparatus aside for direct-display view.

TYPICAL APPLICATIONS

Study of transient electrical phenomena as short as 10 microseconds in duration.

Presentation of tube or transistor characteristics without the necessity of repetition.

Display of frequency response curves without the need of a sweep generator.

Spectrum analyses.

Shock testing.

Electrocardiographic studies.

Detection and measurement of relay bounce or contact noise.

High-speed X-Y plotting.

Investigation of transient behavior of power supply regulation.

Camera shutter timing.

CONDENSED SPECIFICATIONS

5-INCH MEMOTRON STORAGE TUBE

Erasure: internal waveform generator triggered by a push button or by application of a 25-volt, 1-millisecond positive external pulse, erases stored traces within 250 milliseconds.

DC Blanking: CRT grid direct coupled to external or internal blanking gate allows beam to be turned off except during sweep and insures constant sweep-time intensity.

Deflection Plates: available at rear terminal strip for direct connection.

AMPLIFIERS

Frequency Response: DC to 250 kilocycles within 10%.

Rise Time: 2 microseconds.

TRIGGERED LINEAR SWEEP

Range: 10 μsec to 10 seconds per division, adjustable continuously or in 18 calibrated steps.

Trigger: vertical amplifier signal, AC line or external pulse, either polarity, DC or AC coupled. Minimum external trigger amplitude, 0.1 volts.

Ready Light: neon lamp indicates sweep is at left side of screen, ready for trigger.

AMPLITUDE CALIBRATOR

Available at front panel terminal—one kilocycle square wave with peak-to-peak amplitude of 0.01, 0.1, 1.0 or 10 volts, within 3%.

BEAM POSITION INDICATORS

Four neon lamps show position of writing beam when not on screen.

ILLUMINATED GRATICULE

Illuminated scale calibrated in 1/3" squares in 10 × 10 array.

RACK MOUNTING

Model 103-R available on standard 14" × 19" relay rack panel.

DIMENSIONS

13" wide, 14" high, 20" deep. Etched circuit epon-glass electrical chassis.

For additional information on Memo-Scope

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A DIVISION OF THE HUGHES AIRCRAFT COMPANY

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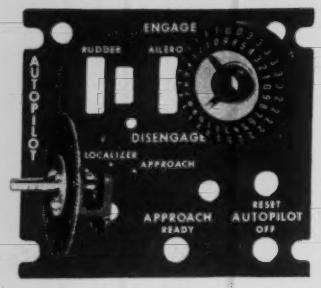
For more information circle **133** on inquiry card.



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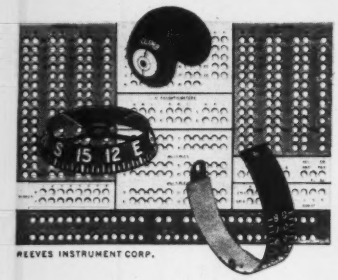

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For more information circle **135** on inquiry card.

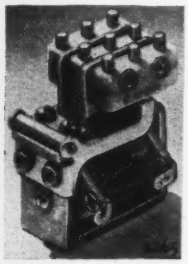
NEW INSTRUMENTS

of wiper pressure, use of precious metals, and keeping winding free from foreign materials during assembly. "Model DDL" is hermetically encapsulated within a gold-plated case.—*Genisco, Inc.*, 2233 *Federal Ave., Los Angeles* 64, *Calif.*

For more information circle **313** on inquiry card.

3P-DT RELAY

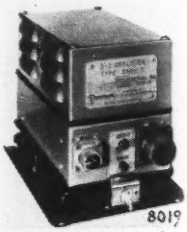
New "Model RL-503-ES" is for military-aircraft electric-power control systems and other precision applications. Size 1⅝" x 1½" x 1⅜". Normally adjusted for 20-v pull-in and 9-v drop-out, but an electrical residual adjustment can be made for a number of drop-out values between 9 and 19 v. This adjustment can be used also in constant current circuits. Contact rating 2.5 amp inductive and 4 amp resistive @30v.—*Joseph Pollak Corp., Freeport St., Boston* 22, *Mass.*



For more information circle **314** on inquiry card.

AIRBORNE D-C AMPLIFIER

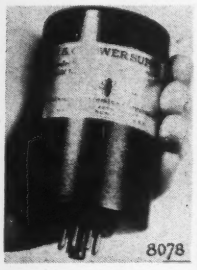
New "Model 2HMA-2," particularly suited for airborne thermocouple or wire strain gage bridge measurements, features isolated input circuit; easily handles applications where switches scan as many as 150 points per second: less than 5 milliseconds rise time and flat response from dc to 400 cps. Output is 0-5 vdc for input to an RDB telemetering system or magnetic tape recorder.—*Doelcam Div., Minneapolis-Honeywell,* 1400 *Soldiers Field Rd, Boston* 35, *Mass.*



For more information circle **315** on inquiry card.

2-LB 50-WATT SUPPLIES

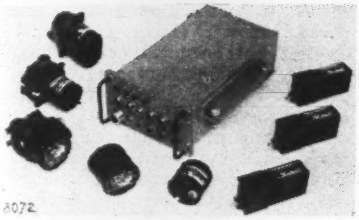
New completely electronic dc to dc transistorized power supplies deliver 50 watts from 24-v input, weigh 2 lb; are especially suitable for guided missiles, rockets, aircraft, marine and police mobile communications and emergency power systems.—*Universal Atomics Corp.*, 19 *E. 48th St., New York* 17, *N. Y.*



For more information circle **316** on inquiry card.

DRONE AUTOPILOTS

New three-axis "Systems 1029, 1029A and 1029B" comprise a vertical gyro, a position and rate gyro, a rate



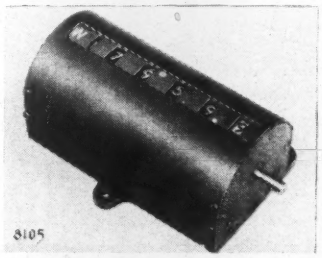
gyro, a "Q" control, an altitude controller, a "brain" junction box, and three servomotors. These units are tied in with the command radio and receiver and the command engine controls.—*Summers Gyroscope Co., 2328 Broadway, Santa Monica, Calif.*

For more information circle **317** on inquiry card.

MISCELLANEOUS

E-W LONGITUDE COUNTER

New "Model 2216" provides longitudinal readings in tenths of a minute divisions. Beginning at 000° 00.0′

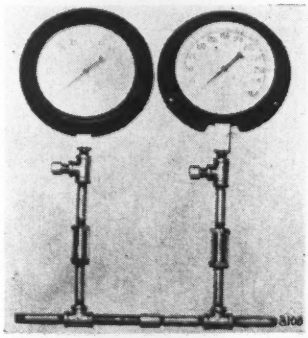


West, it increases in West readings to 179° 59.9′, where it transfers to equivalent of 180° East, declining in East readings back to 000° 00.0′. It is reversible at any point in complete cycle.—*Bowmar Instrument Corp., Plant 1, 2002 Pennsylvania St., Fort Wayne, Ind.*

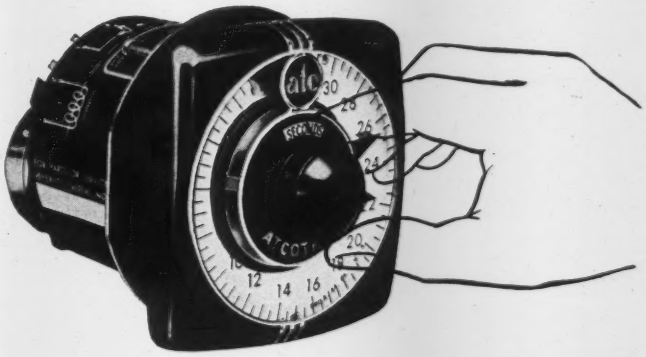
For more information circle **318** on inquiry card.

GAGE-PROTECTION VALVES

New system using "Circle Seal Check and Relief Valves" protects gages cascaded to read over a wide range of system pressures: when system pressure rises above range of an individual gage, its "Circle Seal" protection arrangement functions in two ways: (1) a relief valve (in gage circuit) opens to prevent exceeding gage's maximum pressure; and (2) a



Why do so many equipment manufacturers standardize on this versatile miniature timer?



. . . because Atcotrol makes available a new order of low cost for the installer and of performance for the user. You have to see it and give it a job to do . . . to realize fully its outstanding advantages.

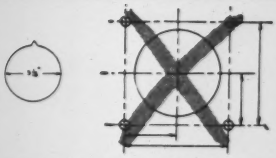
The mounting clamp accommodates any panel thickness up to ½". Snap off a neoprene O-ring and the timer can be removed from both cover and panel . . . even while in operation.

Atcotrol is completely insulated from panel, electrically and physically, by neoprene. Unique design features assure years of maintenance-free operation.

Give flexible, versatile Atcotrol a job to do . . . see for yourself.

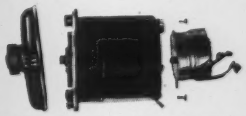
FREE TRIAL OFFER TO EQUIPMENT MANUFACTURERS

You can fully evaluate Atcotrol performance on the equipment you manufacture, under your operating conditions, in your laboratory, without obligation. An Atcotrol will be sent to you for test purposes, without charge, for as long as you need it.



LOW INSTALLATION COST

No critical center-to-center layout or tapping problems. Only one hole with filed notch.



LOW INVENTORY COST

Body of timer is same for all ranges. Change only dial and motor to change timing range.

IMPROVED PRODUCTION AND QUALITY

Full scale reset of less than .1 seconds eliminates waiting between cycles. High accuracy assures uniform quality.

atc®
AUTOMATIC CONTROL SYSTEMS & COMPONENTS

AUTOMATIC TEMPERATURE CONTROL CO.
Subsidiary of Safety Industries, Inc.
5224 Pulaski Avenue, Phila. 44, Pa.
Please send me an Atcotrol on consignment, for test purposes.

NAME_____

COMPANY_____

STREET_____

CITY_____ ZONE____ STATE_____

IN CANADA: POWERLITE DEVICES, LTD., TORONTO, MONTREAL AND VANCOUVER

For more information circle **136** on inquiry card.

check valve acting as an excess flow valve closes to block gage off from system pressures. As an additional safety feature, system furnishes protection in event of Bourdon tube ruptures.—*Circle Seal Products Co., Inc., 2181 E. Foothill Blvd., Pasadena 8, Calif.*

For more information circle **319** on inquiry card.

PORTABLE OXYGEN ANALYZER

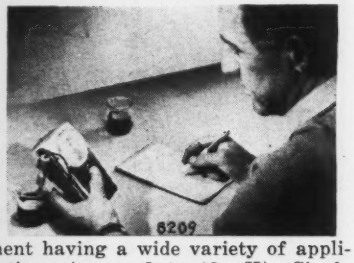
New "Model D2" portable oxygen analyzer can be used for measuring oxygen in almost any mixture of

gases, and accuracy of the reading is not affected by other gases in the mixture. Instrument operates on two flashlight batteries; no chemicals; no special skill needed; accuracy ±0.5% O_2.—*Arnold O. Beckman, Inc., 1020 Mission St., South Pasadena, Calif.*

For more information circle **320** on inquiry card.

PORTABLE pH METER

New low-price "Pocket pH Meter" for acidity and alkalinity measurements is a battery-operated instru-



ment having a wide variety of applications (range 2 to 12 pH). Single electrode combines both reference and glass electrodes.—*Scientific Instruments Div., Beckman Instruments, Inc., Fullerton, Calif.*

For more information circle **321** on inquiry card.

LINE HEATER

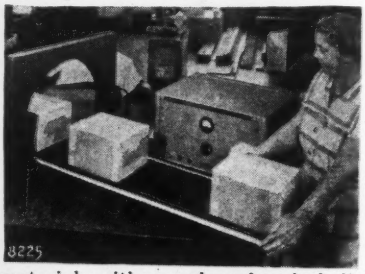
New "Thermal Catalytic Duct," for use in place of an electric heater where electricity is unavailable or too

costly (as in open-air flowmeter houses) uses a flexible metal hose in which a catalytic chemical reaction takes place between air and hydrocarbon vapors supplied by a small pump or blower. (Power for pump can be electrical, chemical, or mechanical; is only a small fraction of heat output.) Reaction in conductor is repeatable, fully-enclosed, explosion-proof; intermittent or continuous; heat output accurately controlled. After installation, device requires no attention other than periodic addition of liquid fuel.—*Instrumentation Associates, 17 W. 60th St., New York 23, N. Y.*

For more information circle **322** on inquiry card.

TRAMP METAL DETECTOR

New "Model TM" automatically signals presence of unwanted tramp metal particles hidden in non-metallic



materials, either packaged or in bulk, and at conveyor speeds up to 1000 fpm; is sensitive to both ferrous and non-ferrous tramp-metal particles.—*J. W. Dice Co., Englewood, N. J.*

For more information circle **323** on inquiry card.

SIMPLYTROL AUTOMATIC PYROMETERS

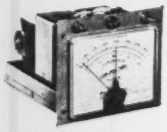
For Control of Temperature

10 standard ranges from −200° to +3000° F.
Accuracy 2% (limit of calibration error).
Sensitivity 4 ohms per millivolt.

Cat. No. 4535, size 10" x 6" x 7". Range 0/1000° F,0/500°C. $135.00

Thermocouple-type automatic pyrometer for controlling temperature in furnaces or ovens and manufacturing processes. Leads between Simplytrol and its thermocouple sensing element may be up to 100 feet or more depending on temperature range and lead wire resistance. Load relay, 5 amperes S.P.D.T. Optional heavy duty relays to 40 A.

Either AUTOMATIC control or LIMIT shutoff. An automatic Simplytrol turns heat on and off to hold required temperature. Proportioning effect can be increased or decreased by changing cam on the sensing cycle. With shorter cycles, control more nearly approaches straight line. A limit Simplytrol locks up when the trip point is reached and remains locked until reset. Use limit Simplytrols for monitoring and safety shutoff or alarm.

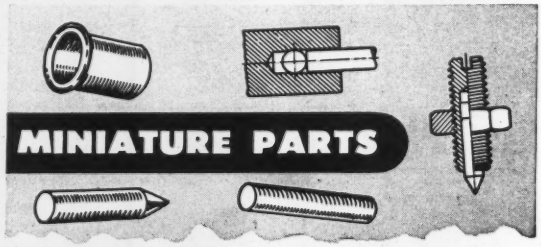


Cat. No. 4532-MFP, size 5"x5½"x8" deep. Range 0/1500°F, 0/800°C. $127.00

Cabinet model for wall mounting or portable shown at top. To the right is an MFP Simplytrol for flush mounting in a cabinet or control panel. Several other mountings are shown in Catalog 4-A. Send for your copy. **Assembly Products, Inc., Chesterland 10, Ohio.** Phone (Cleveland, O.) HAmilton 3-4436. (West Coast: Desert Hot Springs 10, Cal. Phone 4-3133 or 4-2453).

* Booth 106-7, Automation Show, Nov. 26-30, Trade Show Bldg., NYC.

For more information circle **137** on inquiry card.



CUSTOM MANUFACTURE of SMALL PARTS

Instrument Pivots
- As separate items or mounted in components—special steel, heat treated for maximum hardness, polished, metallographic finish. To specifications up to ⅜" diameter.

Shafts and Staffs
- Burrless, plain or alloy steel, heat treated to specifications. Metallographic finish.
- Tubular Products up to ⅜" Diameter, Cut, Flared, Swaged, Formed and Burr-Free. Alloy or Silver Plated.
- Screw-Machine Products up to ¾" Diameter.

SERVICES FOR CUSTOMERS' PARTS
- A Multitude of Services are Available for Customers' Parts at Any Stage of Manufacture. These Include: Controlled-Atmosphere Heat-Treating, Centerless Grinding, Surface Grinding, Special Facilities for Ceramic Rods and Shapes, Knurling, Thread-Rolling to close tolerances, Swaging, Drilling, Milling, Burr Removing, Metallographic Polishing, Barrel-Plating in Alloy or Silver, light Punch-Press Work.

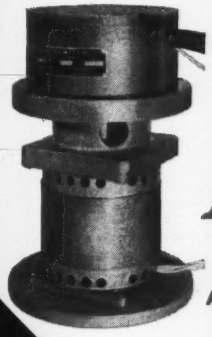
SPECIALTIES
- "Welton" noncorrosive paste solder for hairsprings or similar soldering.
- "Wentonoil" treated bottonwood pith for lubricating instrument pivots.

APPARATUS DESIGN SERVICES
- In Connection with the Design and Fabrication of Precision Miniature Parts.

ENGINEERING ASSISTANCE ON ALL ITEMS

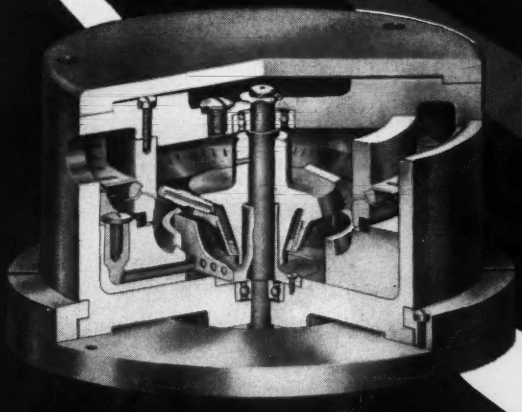
Welton V. Johnson
ENGINEERING COMPANY INC.
92 SUMMIT AVENUE • SUMMIT N J

For more information circle **138** on inquiry card.



NEW SWITCH

for high-speed commutating—



The mercury jet

DELTASWITCH

• no contact bounce • long life

Unique multi-position rotary switch for data sampling where application demands high speed (as many as 10,000 samples per second), long life and low noise. Ideal for thermocouple sampling and strain gauge monitoring to a high-speed analog to digital converter or oscilloscope display.

Deltaswitch utilizes rotating jet of mercury to connect sequentially each of many stationary contacts through low-resistance path to a common pole — no brushes or slip rings. Operates satisfactorily from 1,200 to at least 6,000 rpm. Contact resistance approximately .25 ohm. Noise levels of less than 10 microvolts in most applications. Flexible dwell time.

Copyright 1956 by Detroit Controls Corp.

NC NORWOOD CONTROLS

HIGH reliability
LOW maintenance

NORWOOD CONTROLS
UNIT OF DETROIT CONTROLS CORPORATION
937 Washington St. • Norwood, Mass.

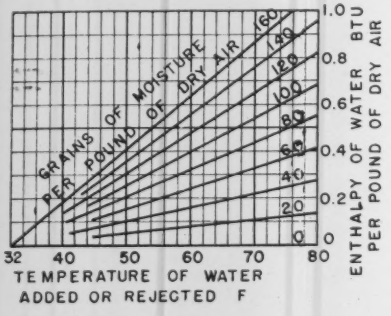
Complete technical information available upon request.

INSTRUMENTS and AUTOMATION Briefs

For this literature circle number on inquiry card.

Humidity Instruments

One simple way to reduce relative humidity is to raise the temperature of the area involved. While the absolute humidity remains constant, the relative humidity decreases as the capacity of the air to hold moisture increases. In



most processes, however, such a simple expedient is not possible, since the temperature is also important, and usually must be held constant. Therefore, other methods of increasing or decreasing the amount of moisture in the air must be resorted to . . . (*From new 22-page Bulletin H-1009, including psychrometric chart, and table of relative humidity, The Bristol Co., Waterbury, Conn.*)

For this literature circle **401** on inquiry card.

Murder in the Model Shop

(The squeeze was on, the bodies were stacked up and the long sleep lay ahead . . .)

My flat feet were cozying up to the desk when the phone rang. My E.S.P. smelled trouble . . . my ear confirmed it. It was Mr. Bigg . . .

"Design engineering is strapped," he moans in a Niagara roar. "We make a fast getaway and come up lame . . . He cascades on and on. A strange story, but all too common nowadays. And then he throws the lightning bolt.

"Help," he yells. "There's murder in the Model Room."

"See you in an hour," I overshout him and grab my slide rule and gear. It was trouble, real trouble.

I back out of the door for a parting look at my girl Friday. Funny how she reminds me of skiing . . . the nose a practice slope and below . . . Devil's Canyon, reserved for experts.

"Later," I whisper.

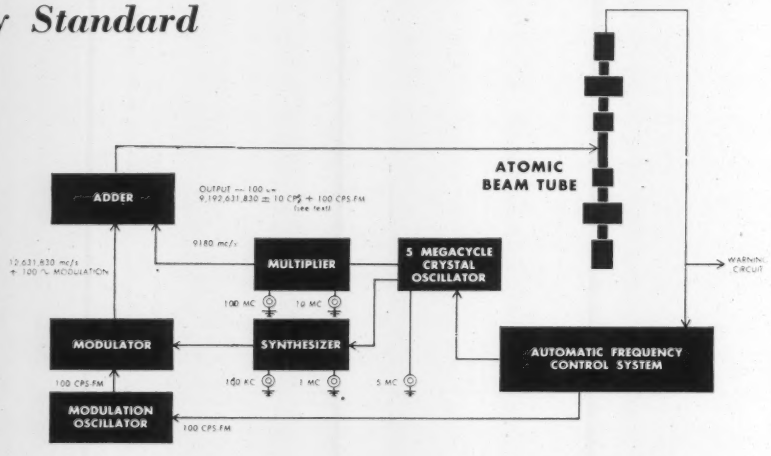
(*From new 54-page "Pocket-Book Mystery—Murder in the Model Shop," by Ernie Razal, a gripping novel of suspense and violence as a stalwart band of engineers face the crossroads—delay in development of engineering models, The Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*)

For this literature circle **402** on inquiry card.

Atomichron Frequency Standard

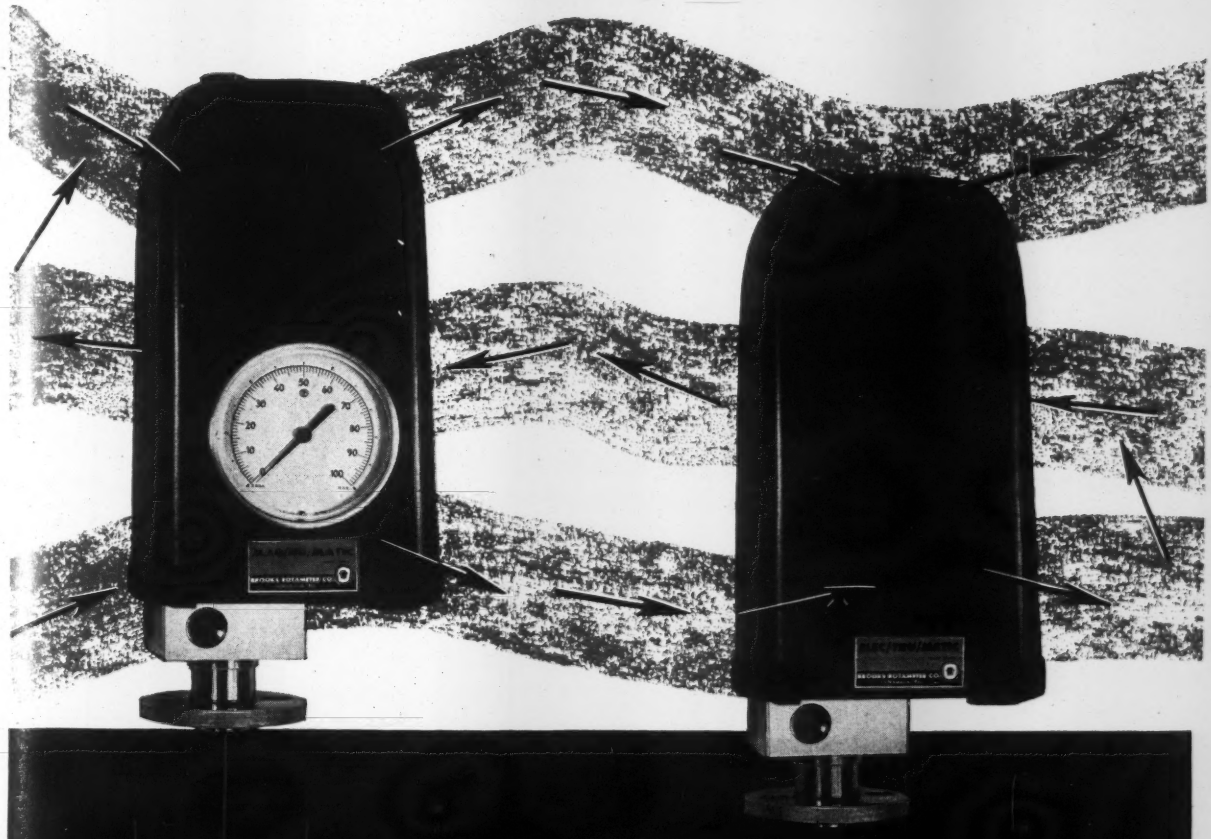
The Atomichron is the first instrument to use the long-discussed atomic principle of frequency control . . . The operation is based on the physical fact that most elements have a resonance frequency at which their nuclei and electrons will change orientation radically, producing a change in the effective energy state of the uncharged particle. In addition, it has been established that different neutral atoms of the same material will be differently affected by magnetic fields, depending upon the relative orientation of electrons to the nucleus.

A reservoir of cesium atoms is placed at one end of a long, evacuated chamber. As heat is applied to the cesium, individual atoms drift away from the pool at approximately the velocity of sound . . . The atom strikes the target, is ionized, and is attracted to the cathode of an electron multiplier, which amplifies the cesium input current a million times. The electron multiplier output current varies with the number and rapidity of impingements of ionized cesium atoms on the cathode . . .



The Atomichron is capable of producing usable signals of 10 dbm at 100 kc/s, 1 Mc/s, 5 Mc/s, 10 Mc/s and 100 Mc/s, all of which are stable to 5 parts in 10^{10} parts. (*From new 8-page bulletin "The National Atomichron", National Company, Inc., 61 Sherman St., Malden 48, Mass.*)

For this literature circle **403** on inquiry card.



A NEW IDEA
in remote flow transmission
the BROOKS *TransiTwins*
are convertible... electric or pneumatic

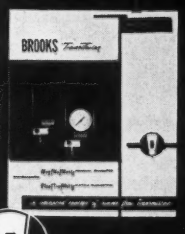
Never before such flexibility . . . such performance. The new Brooks *TransiTWINS* are one basic flow transmitter design in two forms; fulfilling your present *and* future requirements. The Mag/Nu/Matic is a force-balance pneumatic flow transmitter; the Elec/Tru/Matic is electrical. Now, you can switch one internal assembly to interchange electric or pneumatic units . . . for use with any existing receiver. The *TransiTWINS* are interchangeable with Mag/Na/Vue indicators, too, without change of float or float extension, without taking the meter from the line . . . in the biggest step ever taken toward standardized flow instrumentation.

To your technical sense, the high-resolution, transmission accuracy of the *TransiTWINS* will be an eye-opener.

To your practical sense, the maintenance simplicity of this rugged instrument line will be amazing.

If you *can* wait, send for Bulletin 170.

If you *can't*, telephone your nearby Brooks representative.



Send for Bulletin 170.

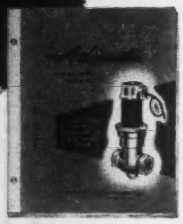
BROOKS ROTAMETER COMPANY
104 EIGHTH STREET, LANSDALE, PA.

Brooks, TransiTwins, Mag/Nu/Matic, Elec/Tru/Matic and Mag/Na/Vue are trade-names of the Brooks Rotameter Co.

For more information circle **140** on inquiry card.

FREE!

NEW SOLENOID VALVE CATALOG



Atkomatic's completely new engineering guide . . . Catalog 200-A

Automatic flow control —air, gas, steam, liquids

Send for it!

Solve YOUR flow control problems Atkomatic-ly

Order from a complete line of two-way solenoid valves . . . fully illustrated and described in Atkomatic's new engineering catalog. Contains flow charts, coil charts, dimensions, applications. For economical, trouble-free operation depend on Atkomatic.

- Built to your specifications
- Individually tested
- Packless
- Tight closing
- Low maintenance
- Rugged, dependable
- Bronze or stainless steel
- Temperatures to 450°
- High and low pressures
- ¼" to 3" full port pipe size

SEND TODAY FOR CATALOG 200-A

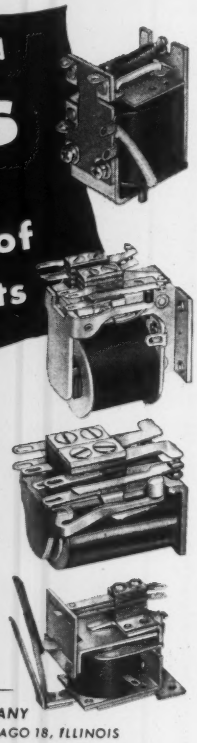
Atkomatic VALVE CO., INC.

DEPT. 1-G, 545 W. ABBOTT ST., INDIANAPOLIS, INDIANA

For more information circle **141** on inquiry card.

Precision Engineered

Relays for a wide range of requirements



Whatever your relay needs may be, it will pay you to contact Comar. Electrical characteristics, sizes and mountings are tailor-made to exactly fit your requirements. Precision-engineered, easier to install, more efficient in operation. Send specifications for our recommendations and prices.

Comar ELECTRIC COMPANY

3349 ADDISON STREET, CHICAGO 18, ILLINOIS

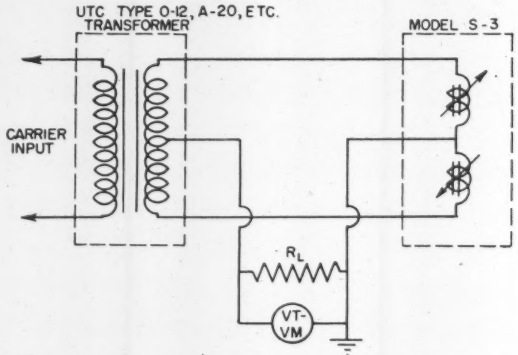
RELAYS · SOLENOIDS · COILS · SWITCHES · HERMETIC SEALING

For more information circle **142** on inquiry card.

BRIEFS—CONTINUED

Pressure Tranducer

The Ultradyne Model S-3 Pressure Transducer is a variable reluctance type unit in which a diaphragm is clamped securely between two gage case halves . . . The Model S-3 is especially suited for making transient pressure measurements in which fast rise time or high frequency response is required. The rise time of the gage is approximately 50 microseconds. Typical applications include: altitude, ram pressure and blast wave measurements, wind tunnel turbulence studies and many others . . . The Model S-3 is also well suited for static and slow response measurements because of its small size and weight, small temperature effects, low values of hysteresis and high output sensitivity . . . (*From new 6-page Bulletin "Pressure Transducer Model No. S-3", Ultradyne Engineering Labs., Inc., P. O. Box* 8007, *Albuquerque, N. M.*)



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ADJ OPTICS

A. D. JONES OPTICAL WORKS

2400 MASSACHUSETTS AVENUE

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A LIST OF MATERIALS WE FABRICATE USED IN OPTICS AND ELECTRONICS

SAWING GRINDING POLISHING DRILLING

ALUM
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BRASS
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*CORNING 707
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FERRITE
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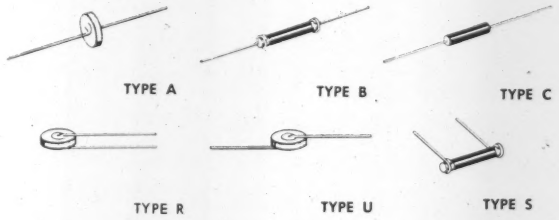
**FLUORIDE, LITHIUM
GERMANIUM
INDIUM ANTIMONITE
INDOX
MELAMINE FIBER GLASS
MICA, SYNTHETIC
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITINATE
TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

*Carried in stock
**Purchased for orders

For more information circle **143** on inquiry card.

Thermistor Manual

Thermistors are thermally sensitive resistors for the automatic detection, measurement and control of physical energy. They are electronic semiconductors whose electrical resistance varies with temperature and lies between that of conductors and insulators. An important distinction between Thermistors and other variable resistance materials is their extreme sensitivity to relatively minute temperature changes.

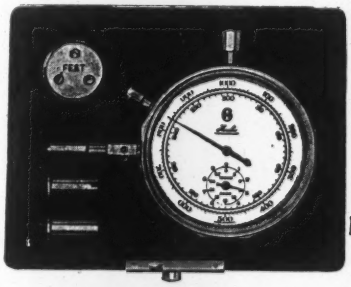


In contrast with metals, which have small *positive* temperature coefficients of resistance, Thermistors have large *negative* temperature coefficients . . . The large negative temperature coefficients and the nonlinear resistance characteristics of Thermistors enable them to perform many unique regulatory functions . . . Temperature control, temperature compensation, safety and warning, voltage regulation, vacuum gaging, flow metering, time delay, sequence switching. (*From new 56-page Thermistor Manual TH-13A, including static and dynamic characteristic curves, Metallurgical Products Department, General Electric Co., Detroit 32, Mich.*)

For this literature circle **405** on inquiry card.

HASLER SPEED INDICATOR

Chronometric Tachometer with separate reset button for cumulative readings



Accurate
Automatic
Durable
Flexible
Portable
Non-magnetic

Size
2¾" x ⅞" x 4"
Spindle incl.

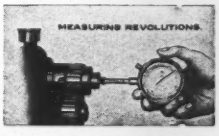
Weight
7¾ oz.
ready for test

Type A 0-20,000 r.p.m.
or 0- 6,000 f.p.m.
Type B 0- 2,000 r.p.m.
or 0- 600 f.p.m.

Shipment within 5 days from stock

To order:
Type A 0-30,000 r.p.m.

All instruments serviced by



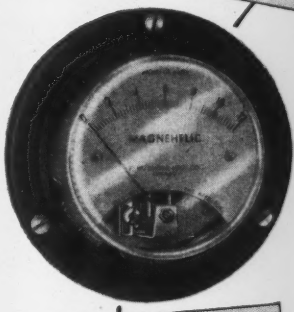
HASLER—TEL COMPANY, INC.

28 Vesey Street, New York 7, N. Y.

U.S. Distributors for Hasler Speed Indicators since 1919

For more information circle **144** on inquiry card.

"MAGNETIC COUPLING"
Exclusive Feature of
DWYER
MAGNEHELIC PRESSURE GAGE



A Precision Instrument Sensitive to Pressure, Pressure Differentials or Vacuum from 0-1" water or 0-2 psi.

The unique design cannot be harmed by sudden pressure surges, shock loading or severe vibration. For accuracy, sensitivity, and long service life the Dwyer Magnehelic Gage cannot be equalled.

Extreme accuracy results from the elimination of friction between the flexible diaphragm and the indicating mechanism. A magnetic force transmits pressure fluctuations to the 3½" easy-to-read dial of the Dwyer Magnehelic Gage.

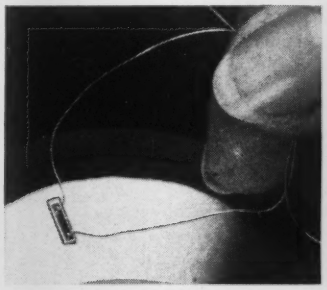
Send for Bulletin No. 250 for complete description today.

F. W. DWYER MFG. CO.

P.O. BOX 373-S **MICHIGAN CITY, INDIANA**

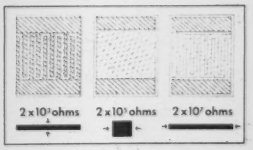
For more information circle **145** on inquiry card.

Kodak Ektron Detector...



A unique lead sulfide photosensitive resistor with the following characteristics:

- Response extends from 0.25 microns to 3.5 microns with maximum sensitivity at 2.2 microns in the infrared
- High signal-to-noise ratio in infrared
- Signal response is almost independent of size of sensitive area
- Unaffected by vibration, small in size
- Available in complex and exact arrays and mosaics



For a booklet giving detailed information on Kodak Ektron Detectors, write Military and Special Products Sales,

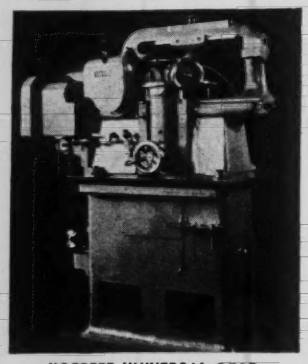
EASTMAN KODAK COMPANY
Rochester 4, N. Y.

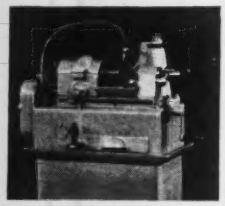
Kodak

For more information circle **146** on inquiry card.

UNIVERSAL GEAR HOBBING MACHINES

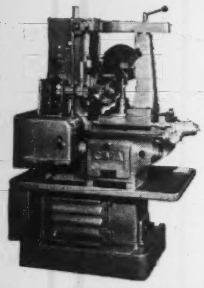
THESE MACHINES ARE UNEXCELLED FOR SIMPLICITY OF OPERATION, PRECISION AND UNIVERSAL APPLICATION





2" KOEPFER Precision Gear Hobber for small Precision Gears up to 2" Dia.

KOEPFER UNIVERSAL GEAR HOBBING MACHINE FOR FINE PITCH GEARS - SPUR, SPIRAL AND WORM GEARS UP TO 4" DIA.



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NEW #3 - UP TO 10" DIA.
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We offer gear cutting equipment for the Watch and Tool Industry, Hobbing Machines for Small Gears, Gear Testers and Tools. We solicit inquiries for our prompt attention.

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200-MG LAFAYETTE STREET • NEW YORK 12, N.Y.

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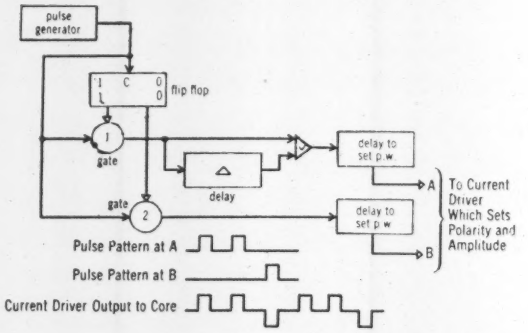
BRIEFS —CONTINUED

Pulse Test Cores

In data handling systems, the ferromagnetic core has many uses—in memory, switching, and logical operations.

Basically, the magnetic core is a digital device. It is usually incorporated in a system which utilizes pulses as



the data carrying signal. Due to its bistable nature it is readily adaptable to binary operation and is generally found in systems employing some form of binary arithmetic or logic . . . Loosely speaking there are three general methods for testing components: (1) Correlation, (2) Simulation, and (3) Substitution . . . (*From new 16-page booklet "Testing Components with Burroughs Pulse Control Systems", Burroughs Corp., Electronic Instr. Div., 1209 Vine St., Phila. 7, Pa.*)

For this literature circle **406** on inquiry card.

FREQUENCY PERIOD TIME INTERVAL

0 CPS to 1 MC! DIRECT READING
Computer-Measurements

NEW! Model 226A UNIVERSAL COUNTER-TIMER

OUTSTANDING FEATURES:

★ Three independent, adjustable trigger level controls permitting full rated sensitivity at any voltage level between —300 and +300 volts.

★ Small voltage increments ordinarily masked by attenuators are easily selected.

★ Simplified color-coded controls and direct read-out in kc, mc, sec, or millisec, with automatic decimal point indication.

★ Oscilloscope marker signals facilitate start and stop trigger level adjustment for time interval measurement of complex waveforms.

A brand new, **multi-purpose** instrument provides precision measurement of frequency, frequency ratio, period (1/frequency) and time interval. Pressure, velocity, acceleration, displacement, flow, RPS, RPM, etc., may also be measured with suitable transducers. The 226A may be used as a secondary frequency standard. **Price: $1,100.00** 100 kc Model 225A: **$840.00**

Data Subject to Change Without Notice — Prices F.O.B. Factory

CC-29

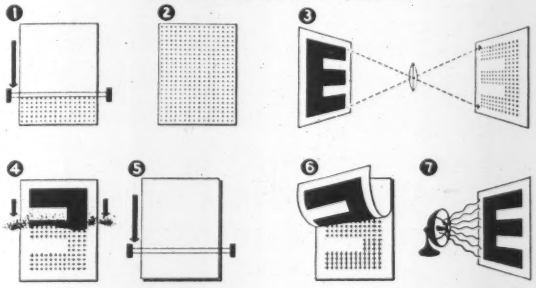
Complete catalog data available
Computer-Measurements Corp.
5528 Vineland Ave., N. Hollywood, Calif., Dept. 80-N

For more information circle **149** on inquiry card.

Photo Panels and Xerography

Xerography is a dry, electrical copying process. It's a direct positive process. That means no negative, no chemicals, water or sensitized paper are required . . .

HOW XEROGRAPHY WORKS



1. Surface of specially coated plate is being electrically charged as it passes under wires.
2. Shows coating of plate charged with positive electricity.
3. Copy (E) is projected through lens in camera. Plus marks show projected image with positive charges. Positive charges disappear in areas exposed to light as shown by white space.
4. A negatively charged powder adheres to positively charged image.
5. After powder treatment (Fig. 4) a sheet of paper is placed over plate and receives positive charge.
6. Positively charged paper attracts powder from plate forming direct positive image.
7. Print is heated for a few seconds to fuse powder and form permanent print.

letters, engineering drawings, office forms, can be copied in less than three minutes onto offset masters and run off on an offset duplicating machine. (*From new 2-page Folder HA-2, The Haloid Co., 20 Haloid St., Rochester 3, N. Y.*)

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And the ALPA is also the ideal camera for your personal use!

	Makro-Kilar E*	Makro-Kilar D**
ALPA 4 (straight reflex)	$259.	$284.
ALPA 5 (prism reflex)	$329.	$354.
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*foc. from inf. to 4", **foc. from inf. to 2"

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For more information circle **151** on inquiry card.

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Unique design of the two-dimensional Model D-2 features—Single micrometer adjustment controls vertical depth of cut, and adjusts height of copy table and pantograph.

Range of ratios from 2 to 1 to infinity!

Accessibility on three sides permitting panels up to 30" diameter to be engraved, milled or profiled. Vertical range over 10" allowing operations on complete chassis, cabinets or other bulky objects.

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Ruggedly constructed heavy duty steel Green Engraver. All functional parts are conveniently within reach of the operator while seated. Accessibility of master type sets stored in lower cabinet trays, tools and accessories contribute to productive capacity.

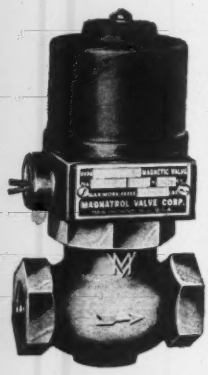
A demonstration with full details is yours upon request.

Literature also available on the smaller Model 106 three-dimensional engraver.

GREEN INSTRUMENT COMPANY
383 Putnam Ave., Cambridge, Mass.

For more information circle **152** on inquiry card.

Eliminate
Costly
Flow Failures



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These three design advantages are your assurance against costly flow failures. Attain dependable, accurate, automatic or remote control of liquids or gases with **Magnatrol Valves.** Installed quickly and easily in connection with . . . flow-meters, thermostats, float and time switches. **Every Magnatrol Valve** is delivered to you—factory tested—guaranteed free from defects in material and workmanship.

Available in normally closed or normally open models. Pressure ranges from zero up to 300 PSI. Voltages to 575.

Catalog containing complete specifications mailed upon request.

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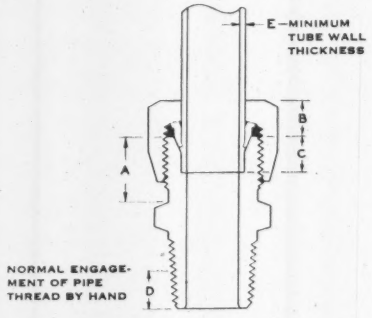
38 Years Experience

For more information circle **154** on inquiry card.

BRIEFS—CONTINUED

Intru-Lok Tube Fittings

Intru-lok fittings are designed to permit tube entry and fitting make-up without removal of the nut and ferrule. The tube, which should be cut off squarely, is simply inserted through the nut and ferrule until it bottoms on the



seat within the fitting body. Then the nut is tightened. The wedging action of the nut when tightened causes the ferrule to "bite" into the outer surface of the tube wall turning up a "shoulder" of metal for a leakproof, vibration-proof connection . . . The cutting edge of the ferrule is not hidden, so the extent of the "bite" is plainly visible when the joint is disconnected to make sure the "bite" is adequate . . . (*From new 12-page Catalog* 4324, *The Parker Appliance Co.*, 17325 *Euclid Avenue, Cleveland 12, Ohio*)

For this literature circle **408** on inquiry card.

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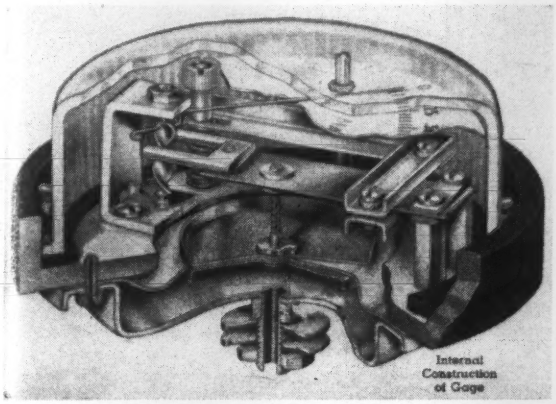
For more information circle **155** on inquiry card.

Magnehelic Gages

The Dwyer Magnehelic Gage consists of two pressure tight compartments separated by a formed flexible diaphragm. "Minus" (less than atmosphere) pressures are connected below the diaphragm—"plus" pressures above the diaphragm.



Internal Construction of Gage

Linked to this flexible diaphragm is a flat cantilever calibrated spring. With a change in pressure on the diaphragm (decreasing from underneath, or increasing from above), the cantilever spring is deflected by the diaphragm movement in proportion to the amount of pressure change.

A powerful Alnico magnet is attached to the outboard end of the spring. The helical pointer assembly, mounted on jewelled bearings, is located vertically between the magnet ends where the magnetic field is most intense. The strength of this magnet is such that the helical assembly

RAYTHEON

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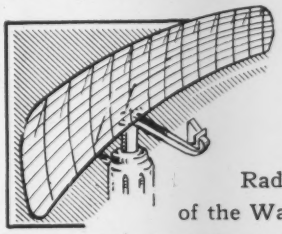

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. . . for component and system design —experience in closed-loop control systems, analogue computers, or magnetic amplifiers desirable.

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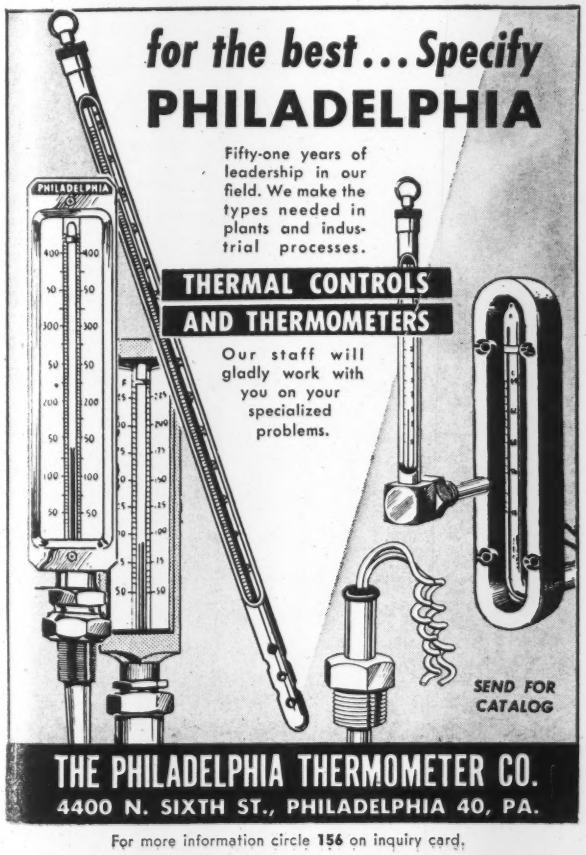
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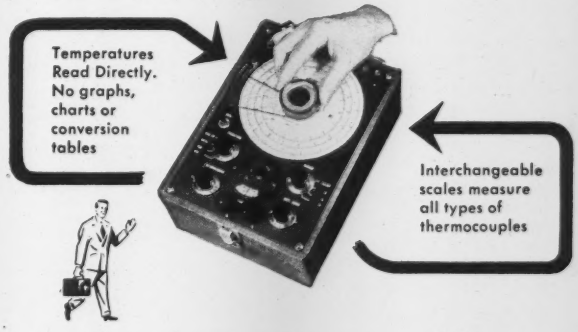
The only portable potentiometer pyrometer with interchangeable direct-reading scales


Temperatures Read Directly. No graphs, charts or conversion tables
Interchangeable scales measure all types of thermocouples

...checks and calibrates all types of temperature instruments.

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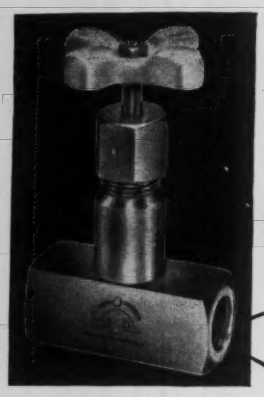

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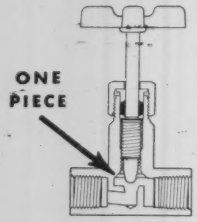
MAXIMUM WORKING PRESSURE 10,000 PSI

. . . for finer regulation of water, oil or gas

First needle valve to combine all the characteristics called for in modern industry. Embodies sturdiest basic construction—machined from solid bar stock—suitable for pressures to 10,000 psi and equally efficient in lower range. Note stem guide fused to body by new "Conoweld" process, eliminating faults of conventional two-piece valves. Stem 416 stainless steel. Stem threads fine pitch for strength and micrometer regulation. Body electro-zinc plated. Sizes ⅛" to 1", globe and angle patterns.



Ask for new Needle Valve Catalog

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* Dpt.42,Skokie,Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd Street, Edmonton, Alberta, Canada

For more information circle **159** on inquiry card.

SIGMA
CALORIMETERS
Accurately RECORD calorific values of gases from 80 B.t.u.'s and up

- Provide reliable, trouble-free service
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- Simple in design
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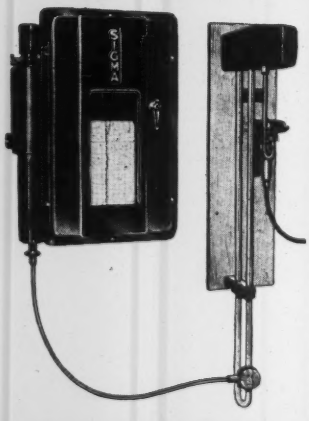


Write for Detailed Catalog

COSA CORPORATION
405 Lexington Ave., New York 17
NATIONAL REPRESENTATIVES FOR SIGMA INSTRUMENT CO., ENGLAND

For more information circle **160** on inquiry card.

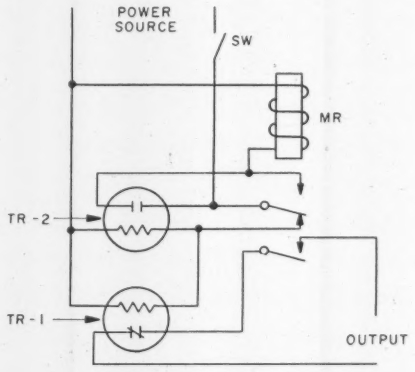
BRIEFS —CONTINUED

is forced to maintain a constant minimum air gap. As the spring (and magnet) is deflected, the spiral rotates the precise amount necessary to maintain this minimum air gap . . . (*From new 72-page catalog comprising 9 sections, F. W. Dwyer Mfg. Co., P. O. Box 373, Michigan City, Ind.*)

For this literature circle **409** on inquiry card.

Rapid Reset Time Delay

Two thermal relays and one magnetic relay can be wired together to produce a timer which has essentially rapid reset characteristics. In addition, this combination



has features which timers of other types cannot provide . . . The two thermal relays are identical except for the contact operating points for which they are set. Both are

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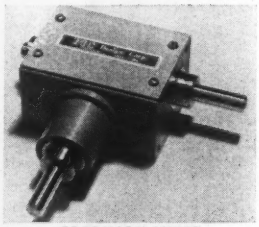

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For more information circle **161** on inquiry card.

energized simultaneously and they heat and cool together. One of them (TR-1) is set to operate its contacts near the start of the heating time and to release its contacts only when nearly cool. The other (TR-2) operates its contacts when the two relays reach the end of the heat-up interval and are ready to start the cooling interval. TR-2 always has NO contacts. TR-1 has NC contacts for a NO output circuit and NO contacts for a NC output circuit. The magnetic relay (MR) always has one pole which is double throw. Its second pole is NO for a NO output and NC for a NC output . . . (*From new 4-page Bulletin AD-3006, G-V Controls, Inc., 28 Hollywood Plaza, East Orange, N. J.*)

For this literature circle **410** on inquiry card.

Recording Galvanometers

Until recently it was generally believed that the practical performance limits of miniature d'Arsonval recording galvanometers had been reached. Basic physical laws dictate that high-frequency response and high sensitivity are mutually incompatible. Ordinarily, one of these qualities is obtained only at the expense of the other. The attainment of both high sensitivity and high-frequency response in a single galvanometer, therefore, represents a signal achievement.

These new instruments permit accurate recording of dynamic data up to 200 cps with no signal amplification between resistance strain gages and recording oscillograph. This approximately doubles the former maximum frequency range for direct recording. For the same frequency range, sensitivity has been quadrupled and a completely new field of low-output strain-gage applications opened . . . (*From new 4-page Bulletin CEC-1559A and Price List, Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*)

For this literature circle **411** on inquiry card.

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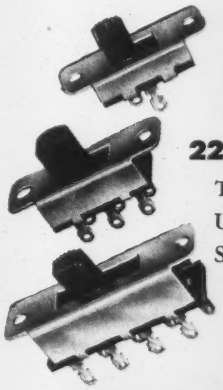

22 STANDARD TYPES

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Reliability Engineering Research
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Columbus, Ohio

INSTRUMENTS and AUTOMATION — New Literature

AUTOMATION

Pneumatic Controller. New 56-page Bulletin A130 describes maker's Series 500 Free-Vane pneumatic controllers with proportional, reset and derivative action, for temperature, pressure, flow, vacuum, etc.—The Bristol Co., Waterbury 20, Conn.
Circle **412** on inquiry card.

Small-Size Process Indicators. New 12-page Bulletin MSP-121 presents maker's complete line of compact measuring instruments for draft, pressure, differential gas pressure and temperature. Can also be used as receiver gages.—Hagan Corp., Pittsburgh 30, Pa.
Circle **413** on inquiry card.

Instrumentation and Control. New 2-page bulletin G41-1 describes maker's building block method of instrumentation and control.—Bailey Meter Co., Iron & Steel Div., 1050 Ivanhoe Rd., Cleveland 10, Ohio.
Circle **414** on inquiry card.

Unitized Controls. New 4-page Bulletin A-800 presents data on maker's new unitized Autronic controls.—Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.
Circle **415** on inquiry card.

Batch Control Systems. New 4-page Catalog 91-109 describes batch control systems for automatically adding fluids to batch processes.—Fischer & Porter Co., Hatboro, Pa.
Circle **416** on inquiry card.

Control Equipment. New 12-page Bulletin 0-100 describes maker's and his subsidiary's, Control Specialty Corp., "Cyclotest and Cycloprint" automatic lease control equipment.—Fisher Governor Co., Marshalltown, Iowa.
Circle **417** on inquiry card.

Automatic Control System. New 4-page Bulletin C-202 presents specifications on maker's "Digimatic" automatic control system for machine tool table positioning.—Electronic Control Systems, Inc., 2136 Westwood Blvd., Los Angeles 25, Calif.
Circle **418** on inquiry card.

Telemetering System. New 4-page bulletin describes maker's transistorized telemeter system for Strain, Temperature, Voltage, Pressure, Vibration, etc. in airborne application.—United Electrodynamics, a division of United Geophysical Corp., 1200 S. Marengo Ave., Pasadena 5, Calif.
Circle **419** on inquiry card.

VALVES

Relief Valves. New 4-page illustrated Bulletin A5212 describes maker's airborne in-line relief valves.—Vickers, Inc., Box 302, Detroit 32, Mich.
Circle **420** on inquiry card.

Valves. Four new 2-page data sheets describe (1) maker's pneumatically operated valves (No. 10-50); gate valves (No. 10-20); hand operated quarter-swing valves (No. 10-40) and combination valve and baffle (No. 10-54). Includes also price list.—Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester 3, N. Y.
Circle **421** on inquiry card.

Reducing and Relief Valve. New 2-page Data Sheet 1A-71 describes maker's "Type F" combination pressure reducing and relief valve for initial pressures up to 4000 psi in water, oil, air or gas service.—Atlas Valve Co., Newark 5, N. J.
Circle **422** on inquiry card.

Air Control Valves. New 60-page catalog and price list describe maker's line of pneumatic valves and cylinders. New 4-page bulletin describes small-bore cylinders for automatic control.—Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.
Circle **423** on inquiry card.

MOTORS

DC Motors. New 32-page Booklet GED-2868 "Why D-C?" illustrates and describes advantages and applications for dc motors—with special attention to automation.—DC Motor and Generator Dept., General Electric Co., Erie, Pa.
Circle **424** on inquiry card.

AC Controller. New 4-page Spec. Sheet GE-500 describes ac controller for measurement and control of ac motors and power circuits.—Hagan Corp., Pgh. 30, Pa.
Circle **425** on inquiry card.

Motors. New 6-page Bulletin 51B-7225D pictures and describes maker's "Types GZ and APZ" totally-enclosed fan-cooled motors.—Allis-Chalmers Mfg. Co., S. 70th St., Milwaukee, Wis.
Circle **426** on inquiry card.

Motors. New 6-page illustrated Bulletin 51B7286G describes maker's "Types GZZ and APZZ" explosion-proof motors.—Allis-Chalmers Mfg. Co., S. 70th St., Milwaukee, Wis.
Circle **427** on inquiry card.

Motors. New 6-page Bulletin 51B6210G describes maker's "Types G, AP, and APWW" open motors.—Allis-Chalmers Mfg. Co., S. 70th St., Milwaukee, Wis.
Circle **428** on inquiry card.

TEMPERATURE

Temperature Control. New 2-page Data Sheet 5.5-1 describes maker's automatic temperature control for non-metallic coating.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Phila. 44, Pa.
Circle **429** on inquiry card.

Pyrometers. New 28-page Catalog C 93-1 describes maker's high-speed sapphire rod radiamatic pyrometer for controlling temperature of molten germanium and silicon.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Phila. 44, Pa.
Circle **430** on inquiry card.

Furnace Controls. New 44-page Catalog and Price List B 43-1 describes strip chart, circular chart and circular scale instruments for furnace and oven control including new "ElectroniK" special class 14 line.—Minneapolis-Honeywell Regulator Co., Indust. Div., Wayne and Windrim Aves., Phila. 44, Pa.
Circle **431** on inquiry card.

Radiation Pyrometer. New 2-page Specification Sheet S939-4 describes maker's target radiamatic radiation pyrometer.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Phila. 44, Pa.
Circle **432** on inquiry card.

Temperature Controllers. New 4-page Bulletin JT-1 describes three-position temperature controllers for furnaces, kilns, ovens and plastic extruders.—West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.
Circle **433** on inquiry card.

Thermistors. New 2-page Price List TH-18 covers maker's disc, rod, washer and washer assemblies.—General Electric Co., Metallurgical Products Dept., Detroit 32, Mich.
Circle **434** on inquiry card.

Bayonet Thermocouples. New 10-page Bulletin 2 describes maker's miniature bayonet thermocouples—Type 2—for temperature measurement of engine and pump-cylinder heads, turbine housings, pipes, electric motors, etc.—Thermo Electric Co., Inc., Saddle Brook, N. J.
Circle **435** on inquiry card.

Extension Wire. New 2-page Specification Sheet S 002-1 describes maker's moisture resistant and flexible polyvinyl plastic insulated thermocouple extension wire.—Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa.
Circle **436** on inquiry card.

Overheat Detectors. New 4-page illustrated Bulletin MC-134 describes maker's line of thermistor overheat detectors.—Fenwal, Inc., Ashland, Mass.
Circle **437** on inquiry card.

Temperature Controller. New 4-page Bulletin MC-133 describes maker's "Series 53000" thermistor-actuated temperature controller.—Fenwal, Inc., Ashland, Mass.
Circle **438** on inquiry card.

Thermostats. New 6-page Catalog MC-135 describes maker's complete line of Thermoswitch temperature sensitive switches.—Fenwal, Inc., Ashland, Mass.
Circle **439** on inquiry card.

Temperature Transducers. New 4-page Bulletin 300 describes maker's temperature measuring probes.—Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.
Circle **440** on inquiry card.

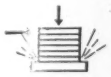
Temperature Probes. Five new 2-page (Bulletins 301-305) describes maker's special-application, air, sur-

face, immersion, and fluid—line temperature probes.—Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.
Circle **441** on inquiry card.

Thermocouple Reference Junction. New 2-page Bulletin 400 pictures and describes maker's thermocouple reference junction for maintaining constant temperature.—Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.
Circle **442** on inquiry card.

Thermal Conductivity Cell. New 2-page Bulletin TRC-9-56 describes maker's "Model TR-11-B" thermal conductivity cell for gas chromatography with 200°C operation.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.
Circle **443** on inquiry card.

Thermometers. New 2-page Bulletin 8 describes maker's line of "E-Mil Becka" glass tube thermometers with a reinforced bulb for stirring and crushing crystals.—The Ealing Corp., Box 90, Natick 7, Mass.
Circle **444** on inquiry card.



PRESSURE, WEIGHT

Weighing Machine. New 8-page Bulletin TA-1002-M-1 describes maker's scale feeders and meters for pneumatically measuring and controlling rate of flow of material by weight.—Wallace & Tiernan, Inc., 25 Main St., Belleville 9, N. J.
Circle **445** on inquiry card.

Pressure Transducers. New 2-page Data Sheet 10.2-6 describes transducers that respond to any linear or nonlinear function of pressure.—Minneapolis-Honeywell Regulator Co., Indust. Div., Wayne and Windrim Aves., Phila. 44, Pa.
Circle **446** on inquiry card.

High-Vacuum Pump Fluid. New 2-page bulletin presents recommended pump fluids for five types of high-vacuum vapor pumps.—Consolidated Electrodynamics Corp., Rochester Div., Rochester 3, N. Y.
Circle **447** on inquiry card.

Pressure Gages. New 4-page Bulletin 403 presents specifications on maker's "Bandrive" test gages.—Instruments and System Div., Norden-Ketay Corp., Wiley St., Milford, Conn.
Circle **448** on inquiry card.

Industrial Weighing. New 8-page Catalog 756 describes maker's "Hydroscale" for weighing or check weighing on cranes or hoists.—Hydroway Scales, Inc., 20624 W. 8 Mile Rd., P. O. Box 4754, Detroit 19, Mich.
Circle **449** on inquiry card.

Test Manometers. New 4-page Catalog 2850 describes maker's 8-scale instrument test manometer used for calibrating aircraft instruments such as altimeters, airspeed indicators etc.—King Engineering Corp., Box 640, Ann Arbor, Mich.
Circle **450** on inquiry card.

FLOW

Flowmeter. New 2-page illustrated Leaflet S222-1 describes maker's float actuated mechanical flowmeters.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Phila. 44, Pa.
Circle **451** on inquiry card.

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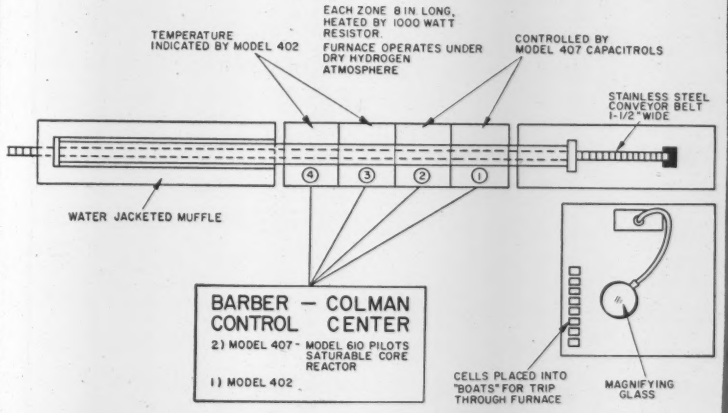
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FURNACE OPERATES UNDER DRY HYDROGEN ATMOSPHERE
CONTROLLED BY MODEL 407 CAPACITROLS
STAINLESS STEEL CONVEYOR BELT 1-1/2" WIDE
④ ③ ② ①
WATER JACKETED MUFFLE
BARBER — COLMAN CONTROL CENTER
2) MODEL 407 - MODEL 610 PILOTS SATURABLE CORE REACTOR
1) MODEL 402
CELLS PLACED INTO "BOATS" FOR TRIP THROUGH FURNACE
MAGNIFYING GLASS

Diagram above shows smaller of two furnaces producing transistor cells. Two minute balls of indium are alloyed onto opposite sides of a .002 in. thick slice of germanium. Zones of germanium-indium alloy must grow inward toward central plane of germanium wafer to within .001 in. of each other. Conveyor belt carries cells through four furnace zones heated by resistors rated at 1000 watts per zone. Two Model 407 Capacitrols control temperature of zones 1 and 2. One Model 402 Capacitrol indicates temperatures in zones 3 and 4 by switching.

Photo at left shows workers preparing cells before Wheelco Control Center of larger, 12-zone furnace on which Model 407 Capacitrols similarly control and indicate temperature. Controlled temperatures are 610 to 550 C.

By applying accurate Wheelco 400 Series Capacitrols to two furnaces, RCA solved the key problem of process temperature control during crystal growth in its Harrison, New Jersey, transistor plant. The 400 Series Capacitrols are completely self-contained, direct-deflection-type indicating controllers with a wide range of application to jobs where temperature control is critical. 400 Series Capacitrols operate on the proved and accepted Wheelco "electronic control principle"—a precise control circuit constantly sensing changes in the measured variable. Simple design, careful workmanship, and quality materials insure long, trouble-free service. Write today for details of RCA's challenging problem and the simple solution found in Wheelco's 400 Series Capacitrols.

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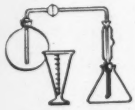
Flow Computer. New 4-page Catalog 310398 presents specifications on maker's totalizing flow computer.—Librascope, 808 Western Ave., Glendale, Calif.
Circle **452** on inquiry card.

Flowmeter. New 2-page Bulletin 45 describes maker's area type "Flotometer" for laboratory or pilot plant work.—Bayley Instrument Co., P. O. Box 538, Danville, Calif.
Circle **453** on inquiry card.

Flow Restrictors. New 2-page specification sheet presents data on maker's precision flow restrictors for gases.—Del Mfg. Co., 1005 South Central, Los Angeles, Calif.
Circle **454** on inquiry card.



ANALYTICAL, LABORATORY

X-Ray Diffraction. New 4-page brochure Pub. 7A-3690 describes use of x-ray diffraction for research, production control, etc.—General Electric Co., X-Ray Dept., Milwaukee 1, Wis.
Circle **455** on inquiry card.

Infrared Analyzer. New 2-page Bulletin 495 describes and illustrates maker's "Model 21" L/B infrared analyzer.—Beckman Instruments, Inc., Process Instruments Dept., 2500 Fullerton Rd., Fullerton, Calif.
Circle **456** on inquiry card.

Gas Analyzer. New 4-page Brochure 488 presents information on maker's RF mass spectrometer gas analyzer for stream analysis.—Beckman Instruments, Inc., Scientific Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.
Circle **457** on inquiry card.

Gas Analysis Equipment. New 8-page Brochure ND46-91(6) describes maker's Speedomat (Type G and Type H) instruments for thermal conductivity gas analysis.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Pa.
Circle **458** on inquiry card.

Vapor Fractometer. New 16-page descriptive brochure illustrates maker's "Model 154-B" gas chromatography instrument.—The Perkin-Elmer Corp., Norwalk, Conn.
Circle **459** on inquiry card.

Process Stream Color and pH. New 12-page Reprint R-87 on "pH Control in Industrial Waste Treatment." New 8-page Reprint R-85 presents "Practical Applications of Flow Colorimetery."—Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.
Circle **460** on inquiry card.

Agitated Pot Still. New 2-page bulletin pictures and describes maker's "ASCO Model P" high-vacuum agitated pot still.—Arthur F. Smith Co., Rochester 3, N. Y.
Circle **461** on inquiry card.

Gas Chromatography. New 4-page illustrated Bulletin 831 describes maker's "Kromo-Tog" Model K-3 for gas and vapor-phase chromatography.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.
Circle **462** on inquiry card.

Fluorescence Meter. New 19-page Bulletin 392 describes and prices maker's "Model 540" multiplier fluores-

cence meter and accessories.—Photovolt Corp., 95 Madison Ave., New York 16, N. Y.
Circle **463** on inquiry card.

Lathe Glass Blowing. New 30-page manual describes and illustrates ten projects of glass blowing on the glass lathe emphasizing basic techniques.—Bethlehem Apparatus Co., Inc., Hellertown, Pa.
Circle **464** on inquiry card.

Lab Equipment. New 4-page Bulletins 5660 describe maker's "Power-O-Matic" control systems, muffle furnace, mechanical convection ovens, pyrometers, etc.—Boder Scientific Co., 810-814 Penn Ave., Pittsburgh 22, Pa.
Circle **465** on inquiry card.

GAGING

Radiation Gages. New 12-page Circular No. 600 describes maker's "RAD-I-ACC" radiation gages for thickness measurement of any continuous strip.—Pratt & Whitney Co., Inc., Charter Oak Blvd., West Hartford 1, Conn.
Circle **466** on inquiry card.

Shock Testing Machine. New 2-page specification sheet presents data on maker's variable duration shock machine.—Associated Testing Labs., Inc., Mfg. Div., Clinton Rd. at Rt. 46, Caldwell, N. J.
Circle **467** on inquiry card.

Metrology. Three new reprints from proceedings of Symposium on Engineering Dimensional Metrology" feature articles on "New Precision Internal Measuring Machine", "Large Scale Metrology", and "Work on Engineering Dimensional Metrology at the National Physical Lab. (England) "—Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.
Circle **468** on inquiry card.

TESTING

Lube Testing Machines. New 2-page illustrated Bulletin 106 describes maker's "Model LFW-1" lubricant testing machine.—Alpha Molykote Corp., Testing Machine Div., 65 Harvard Ave., Stamford, Conn.
Circle **469** on inquiry card.

Ultrasonic Testing Instrument. New 4-page Bulletin 14100-3 pictures and describes maker's "Sonizon" ultrasonic testing instrument.—Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.
Circle **470** on inquiry card.

Abrasion Test Set. New 6-page Bulletin 5604 pictures and describes maker's "Model 174" standard abrasion testing set.—Taber Instrument Corp., 111 Goundry St., North Tonowanda, N. Y.
Circle **471** on inquiry card.

Flaw Locator. New 4-page bulletin describes maker's "Dy-Check" dye penetrant method of flaw location.—Turco Products, Inc., 6135 So. Central Ave., Los Angeles 1, Calif.
Circle **472** on inquiry card.

NUCLEONICS

Safety Amplifier. New 4-page Specification Sheet S901-1 describes and illustrates maker's safety amplifier for nuclear reactor control.—Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia 44, Pa.
Circle **473** on inquiry card.

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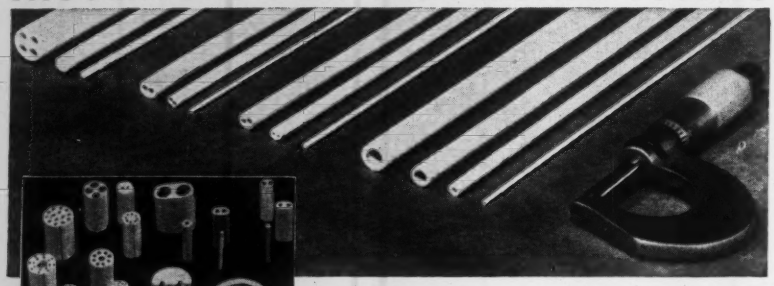

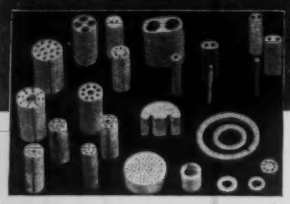

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NEW LITERATURE

Leak Detecting System. New 8-page Brochure 7071.1 describes maker's "Radiflo" non-destructive atomic energy leak detection system.—American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.
Circle **474** on inquiry card.

SPECIFIC GRAVITY

Hydrometers. New 8-page Bulletin G-3 pictures and describes maker's line of "Princo" hydrometers and thermo-hydrometers.—Precision Thermometer and Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.
Circle **475** on inquiry card.

HUMIDITY, WATER

Hygrometer. New 2-page Specification Sheet 498 pictures and describes maker's electrolytic hygrometer for determining water content of non-corrosive gases.—Beckman Instruments, Inc., Scientific Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.
Circle **476** on inquiry card.

Water Conditioning Systems. New 4-page Brochure 4801-A describes maker's hot lime-zeolite water conditioning systems for boiler feeds.—Cochrane Corp., 17th St., & Allegheny Ave., Phila. 32, Pa.
Circle **477** on inquiry card.

Automatic Water Filter. New 10-page Bulletin 909 describes maker's AWF filters for high-polish industrial water, process liquids and gases, etc.—R. P. Adams Co., Inc., 448 Park Drive, Buffalo 17, N. Y.
Circle **478** on inquiry card.

OPTICAL

Color-Difference Meter. New 2-page Data Sheet 10.10-6 describes theory, accuracy and features of automatic color difference meter used with Brown's "ElectroniK" amplifier and motors.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves, Phila. 44, Pa.
Circle **479** on inquiry card.

Electron Microscopes. New 4-page bulletin presents engineering data and forty-four typical uses for two electron microscopes.—North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.
Circle **480** on inquiry card.

Optical Supplies. New catalog describes maker's prisms, eyepieces, first surface mirrors ,etc.—A. Jaegers, 691-N Merrick Rd., Lynbrook, N. Y.
Circle **481** on inquiry card.

Micro-Projector. New 12-page bulletin describes maker's micro-projector used in thread forming, gear cutting, tool making, etc.—Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y.
Circle **482** on inquiry card.

Miniature Camera Tube. New 2-page bulletin describes miniature pho-

toconductive camera tube 3½" long by 0.6" dia.—Resitron Labs., Inc., 2908 Nebraska Ave., Santa Monica, Calif.

Circle **483** on inquiry card.

Spectroscopes. New 20-page catalog describes Beck (London) diffraction, prism, reversion, ultra-violet spectroscopes, etc. Includes price list.—The Ealing Corp., Box 90, Natick 3, Mass.

Circle **484** on inquiry card.

Industrial Photography. New 64-page handbook "How-To-Do-It Pictures" discusses and illustrates techniques for producing instruction-type illustrations.—Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

Circle **485** on inquiry card.

Dichroic Coatings. New 2-page Bulletin TB-200 presents specifications on maker's dichroic coatings.—Optical Coating Laboratory, Inc., 1035 Sebastopol Rd., Santa Rosa, Calif.

Circle **486** on inquiry card.

COMPUTERS AND DATA HANDLING

Digital Designing. New 16-page booklet "Four Dimensions in Digital Design—Pulse Techniques for Modern Control" presents data on use of digital techniques for testing, information handling and control.—Electronic Instruments Div. of Burroughs Corp., 1209 Vine St., Philadelphia 7, Pa.

Circle **487** on inquiry card.

Analog Computer. New 8-page AIEE No. DP 56-448 Paper presents design and application features of maker's airborne analog computer.—Servo Corp. of America, 20-20 Jericho TP., New Hyde Park, L. I., N. Y.

Circle **488** on inquiry card.

Computers. New 16-page Brochure 108 illustrates and describes maker's "Series 400 Reac" analog computer and components.—Reeves Instrument Corp., 215 E. 91st St., N. Y. 28, N. Y.

Circle **489** on inquiry card.

Digital System and Components. New 12-page brochure describes maker's "P-T-F" (Pressure-Temperature-Flow) digital system and components.—BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

Circle **490** on inquiry card.

Digital Counting. New 6-page bulletin describes, illustrates and prices maker's electronic digital counting and frequency measuring instruments.—Westport Electric, 149 Lomita St., El Segundo, Calif.

Circle **491** on inquiry card.

Magnetic Memories. New 8-page Bulletin MM-1 describes the operation of coincident current "Ferramic" magnetic memories.—General Ceramics Corp., Keasbey, N. J.

Circle **492** on inquiry card.

Memory Planes. New 4-page Bulletin MP-105 presents specs and data on standard configurations for maker's "Ferramic" magnetic memory planes.—General Ceramics Corp., Keasbey, N. J.

Circle **493** on inquiry card.

Simulators. Two new 2-page bulletins describe maker's "Model 10 Series" simulation table for testing gyros, accelerometers and automatic stabilization systems; and "Model 20

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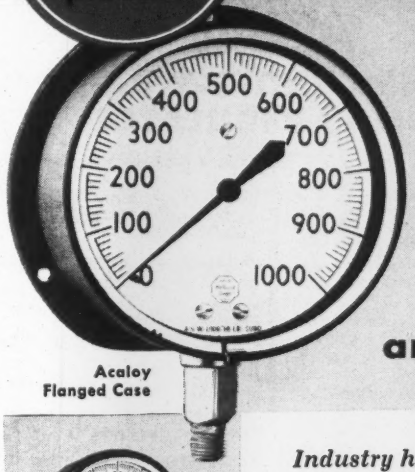

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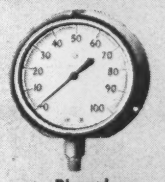
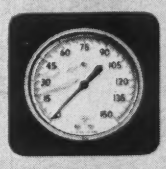


Phenol Turret Case

Acaloy Flush Case



Acaloy Square Flush Case

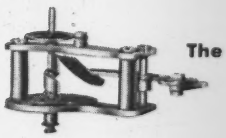
Industry has found in the HELICOID Gage, the most durable and efficient instrument ever devised to meet pressure-indicating requirements.

No Gears—No Teeth to Wear Out!
The exclusive HELICOID Movement is a simple, gearless cam-and-roller design with no teeth to wear out. It provides long and trouble-free service with a minimum of maintenance.

Sustained Accuracy—Longer Life
Because of advanced design, quality control in manufacture, and endless testing, HELICOID Gages produce more sensitive response to pressure changes. Their accuracy *endures*—even after millions of cycles.

Lowest Cost per Gage per year
These gearless gages go on performing day in and day out with little or no maintenance. This economy, together with long life, adds up to the fact that HELICOID Gages cost less per gage per year than any other gage you can buy.

Gages for vacuum and compound service. Pressure ranges up to 20,000 psi.



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For more information circle **170** on inquiry card.

Fastest Voltage Regulator Available

THE CURTISS-WRIGHT LINE REGULATOR

The Curtiss-Wright Model EE 100 Distortion Eliminating Voltage Regulator provides faster recovery time than any other regular on the market—less than 1/50th cycle, or 330 microseconds. It also reduces typical power line distortion to less than 0.3%. Capacity is 1.4 KVA.

Now being installed in a rapidly growing number of laboratories and production test departments, it provides simpler, more accurate calibration of meters, better design of transformers, synchros and motors . . . easier testing with fewer rejects, more accurate measurement of magnetic properties and receiver sensitivity . . . better a.c. computer performance, elimination of fast line transient effects. Write for details.

Electronic Component & Instrument Sales Department

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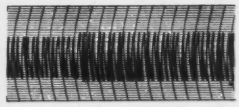
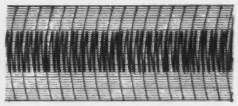
Simultaneous recordings of response to step change in 60 cps voltage.



Typical electromechanical regulator output. Recovery time over 4 seconds.



Curtiss-Wright DEVR output. Full recovery 330 microseconds.

For more information circle **171** on inquiry card.

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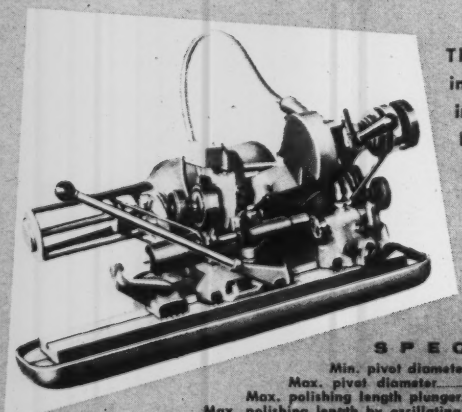
HAUSER type 241 PIVOT BURNISHER



This HAUSER 241 assures instrument, meter and allied industries of the finest pivot burnishing. Mirror finished pivots by this sturdy machine means superior bearing action. Spring collet chucking. Built-in coolant system.

SPECIFICATIONS

Min. pivot diameter	.008"
Max. pivot diameter	.250"
Max. polishing length plunger	.500"
Max. polishing length by oscillating work under wheel	1¼"
Max. total length of workpiece	5"
Driving motor built-in	1/5 HP

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NEW LITERATURE

Series" signal simulator for testing ac—autopilots and servo systems.—Micro Gee Products, Inc., 6100 W. Slauson Ave., Culver City, Calif.

Circle **494** on inquiry card.

Digital Printers. New 12-page illustrated Brochure 671-71-2 describes maker's "Digit-matic" high-speed serial and parallel entry digital printers.—Victor Adding Machine Co., 3900 N. Rockwell St., Chicago 18, Ill.

Circle **495** on inquiry card.

Magnetic Memory System. New 4-page illustrated brochure describes maker's "Magdelay" magnetic memory systems for delayed control of high-speed continuous process lines, etc. 2-page specification sheet is for Model 1000.—Automation, Inc., 212 Worcester St., Wellesley Hills 82, Mass.

Circle **496** on inquiry card.

TUBING

Tubing Selection Data. New 8-page Catalog File 4305 contains charts and tables to aid in selecting tube sizes, wall thickness and material for various operating conditions.—Parker Appliance Co., Tube & Hose Fittings Div., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **497** on inquiry card.

Welding Tube Fittings. New 12-page Catalog 4370 presents maker's line of socket-type tube fittings for welding.—Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **498** on inquiry card.

Capillary Tubing. New 4-page Bulletin C & B 7500 presents features and specs of maker's "Capilator" capillary tube for restriction purposes.—Wolverine Tube Div., Calumet & Hecla, Inc., Guardian Towers, Guardian Bldg., Detroit 26, Mich.

Circle **499** on inquiry card.

Tubing. New 6-page Data Memorandum 2 describes maker's Weldrawn tubing. Includes table of analysis and production limits.—Superior Tube Co., 1566 Germantown Ave., Norristown, Pa.

Circle **500** on inquiry card.

Tubing. New 6-page Data Memorandum No. 1 lists 121 metals and alloys for standard, special tubing.—Superior Tube Co., 1566 Germantown Ave., Norristown, Pa.

Circle **501** on inquiry card.

Plastic Tubing. New 28-page Bulletin T-97 describes maker's "Tygon" flexible plastic tubing. Includes table of resistance to chemicals.—U. S. Stoneware Co., Plastics and Synthetics Div., Akron 9, Ohio.

Circle **502** on inquiry card.

Plastic Tubing. New 2-page bulletin describes maker's "Bardex" "virtually uncrushable" plastic tubing.—Newage International, Inc., 222 York St., Jenkintown, Pa.

Circle **503** on inquiry card.

Plastic Pipe. New 8-page Bulletin CE-57 describes maker's flexible polyethylene plastic pipe and fittings.—Supplex Co. Div. of American Hard Rubber Co., 93 Worth St., New York 13, N. Y.

Circle **504** on inquiry card.

MONITORS

Neon Lamp. New 2-page Data Sheet 1L 302 pictures and describes maker's "NE2C" subminiature neon lamp with midget flanged base.—Circon Component Co., Santa Barbara Airport, Goleta, Calif.

Circle **505** on inquiry card.

Combustible Gas Alarm. New 2-page illustrated specification sheet describes maker's "J-W Sentinel" audible gas alarm unit.—Johnson-Williams, Box 6, Palo Alto, Calif.

Circle **506** on inquiry card.

COMMUNICATIONS

Threshold Indicator. New 2-page bulletin describes maker's "91296-1" threshold indicator for radio interference.—Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, Calif.

Circle **507** on inquiry card.

Communications Receiver. New 8-page Brochure R-9903 describes maker's "R5200 Servoflight" VHF receiver.—Servo Corp. of America, 20-20 Jericho TP., New Hyde Park, N. Y.

Circle **508** on inquiry card.

Communications Receiver. New 8-page folder pictures and describes maker's "Servoflight R5200" VHF communications receiver.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.

Circle **509** on inquiry card.

Radio Equipment. New 6-page Brochure C.3102 describes maker's "Carfone" line of 2-way radio equipment for installation on electrical and gasoline materials handling vehicles.—Radio Corp. of America, Communications Prod. Dept., Camden 2, N. J.

Circle **510** on inquiry card.

Microwave Accessories. New 4-page Bulletin 435 describes parabolic antennas for tropospheric scatter and line-of-sight communications.—New 2-page Bulletin 433 describes G-Line assembly for microwave transmission line.—Prodelin Inc., 307 Bergen Ave., Kearny, N. J.

Circle **511** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Panel Instruments. New 4-page Bulletin 81556-T presents dimensional diagrams, tables and full size scales of maker's round, rectangular and special instruments.—Triplett Electrical Instrument Co., Bluffton, Ohio.

Circle **512** on inquiry card.

Servo Analyzer. New 4-page illustrated Bulletin TDS-1100 describes maker's "Series 1100" servo system-analyzer.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

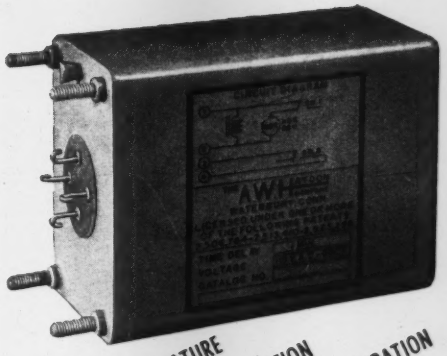
Circle **513** on inquiry card.

Microvoltmeter. New 2-page Bulletin 5-M describes maker's "Model 202B" d-c microvoltmeter and amplifier.—Kay Lab., 5725 Kearney Villa Rd., San Diego 12, Calif.

Circle **514** on inquiry card.

Circuit Testing. New 8-page folder pictures and describes maker's elec-

a proven performer always in control



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2. Vibration: 5-55 CPS with 10g maximum acceleration.
3. Shock: 30g (11ms duration)
4. Hermetically sealed units meet military requirements for fungus, humidity, and salt spray.

Write for Bulletin AWH TD402 describing 6400 Series DC, 11400 Series AC, 24300 Series 400 Cycle.

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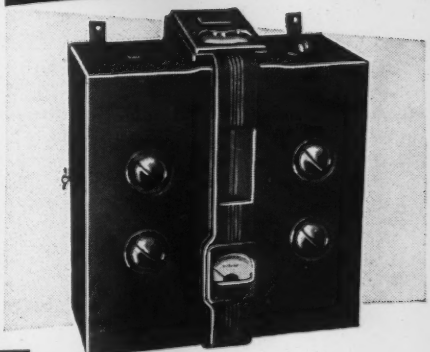
practical and accurate

the durably constructed

for measuring oxygen or hydrogen present as impurities in other gases

DEOXO INDICATOR



The DEOXO INDICATOR permits a continuous and accurate reading of minute quantities of oxygen or hydrogen.

This equipment offers optimum efficiency within the range of .001% to 1.000% for oxygen and .002% to 2.000% for hydrogen.

A self-contained calibrating unit is included as an integral part of this unit. If desired, the DEOXO INDICATOR can be connected to controllers and recorders.

Write for additional data, technical assistance.

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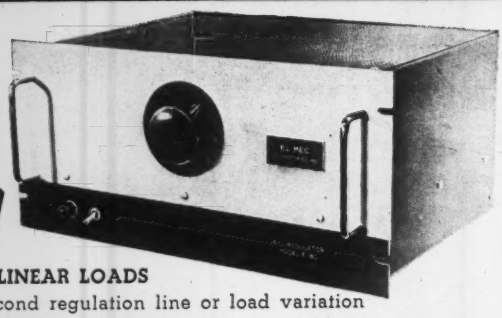

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Model	Specifications		
E-80-1	115 V.	1.5 Amp.	60 Cycles
E-80-1V	Variable 50-125 V.	1.5 Amp.	60 Cycles
E-80-2	115 V.	2.5 Amp.	60 Cycles
E-80-2V	Variable 50-125 V.	2.5 Amp.	60 Cycles
E-84-2	115 V.	2.5 Amp.	400 Cycles

D.C. REGULATORS TOO!

If you are quality conscious and insist on your D.C. power supplies being dependable, conservatively rated, carefully specified, and properly built – then El Mec should be your source. Send for a supply of design data sheets and submit your specifications. We will be happy to send you an engineered quotation or have our representative call.

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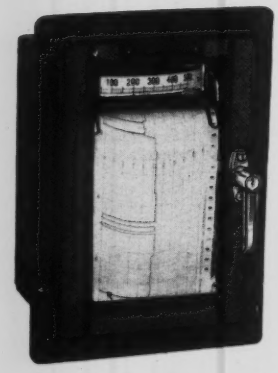

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For more information circle **176** on inquiry card.

NEW LITERATURE

trical circuit testing equipment.—Dit-Mco, Inc., 911 Broadway, Kansas City 5, Mo.

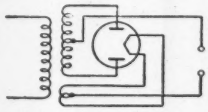
Circle **515** on inquiry card.

Frequency Analyzer. New 4-page Bulletin 625-1 pictures and describes maker's "TP-625" frequency analyzer for ranges from 2 to 25,000 cps.—Technical Products Co., Instrument Div., 6670 Lexington Ave., Los Angeles 38, Calif.

Circle **516** on inquiry card.

Utility Tester. New 4-page bulletin describes maker's "Model 70" utility tester for measuring voltages, currents, resistances and leakages, etc.—Moss Electronic Dist. Co., Inc., 3849 Tenth Ave., New York 34, N. Y.

Circle **517** on inquiry card.



POWER SUPPLIES

Electronic Battery Charger. New 4-page illustrated Brochure GEA-3179D describes maker's "Phano-Charger" self-regulating electronic battery charger for switchgear control, and emergency power and light batteries.—General Electric Co., Schenectady 5, N. Y.

Circle **518** on inquiry card.

Power Supplies. New 6-page Supplement to Cat-56 describes maker's "Com-Pak" regulated power supplies. Includes prices.—Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y.

Circle **519** on inquiry card.

Power Supplies. New 6-page illustrated Bulletin 100 describes maker's low-voltage dc power supplies for airborne applications.—Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.

Circle **520** on inquiry card.

Power Supplies. New 2-page Bulletin 200 pictures and describes maker's regulated high-voltage dc power supplies.—Arnoux Corp., 11924 W. Washington Blvd., Los Angeles 66, Calif.

Circle **521** on inquiry card.

Power Supplies. New 24-page brochure presents specifications, construction features, etc. of maker's high voltage, high current, variable, semi-fixed, and fixed well regulated power supplies.—Deltron, Inc., 2905 N. Leithgow St., Phila. 33, Pa.

Circle **522** on inquiry card.

Power Supplies. Two new 2-page bulletins describe and illustrate maker's "Models RS-317 and RS-305" regulated power supplies.—Trans Electronics Co., Canoga Park, Calif.

Circle **523** on inquiry card.

DC Power Supplies. New 4-page Bulletin DC-245 pictures and describes maker's "DC Solavolt" adjustable constant voltage direct current power supply.—Sola Electric Co., 4633 W. 16th St., Chicago 50, Ill.

Circle **524** on inquiry card.

Power Supply and Bridge Control. New 2-page bulletin SPS-8-56 describes maker's power supply and bridge control Model 9293-B for gas chromatography or other instru-

mental gas analysis.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.
Circle **525** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

Magnetic Starters. New 12-page illustrated Bulletin GEA-6481 presents methods of modifying GE's magnetic starters to fit special conditions.—General Electric Co., Schenectady 5, N. Y.
Circle **526** on inquiry card.

Delay Lines. New 6-page Catalog 6-56 covers maker's line of lumped-parameter electrical delay lines.—Underwood Corp., Electronic Computer Div., 35-10 36th Ave., Long Island City 6, N. Y.
Circle **527** on inquiry card.

Electrical Contacts. New 28-page catalog presents materials, characteristics and applications of maker's electrical contacts.—Baker & Co., Inc., Contact Div., 113 Astor St., Newark 5, N. J.
Circle **528** on inquiry card.

Chassis Kits. New 8-page bulletin describes maker's experimenter's chassis kits which provide quick set up of electronic circuitry with simple hand tools.—Vector Electronic Co., 3352 San Fernando Rd., Los Angeles 65, Calif.
Circle **529** on inquiry card.

Electronic Components. New 16-page issue "This Month" (Aug.-Sept. 1956) presents list of timers, time switches; constant voltage transformers; relays; electrical reset steppers; etc. distributed by company.—Herbach & Rademan, Inc., 1204 Arch St., Philadelphia 7, Pa.
Circle **530** on inquiry card.

1957 Handbook and Buyers' Guide

The questionnaire of Interelectronics Corp., 2432 Grand Concourse, New York 58, N. Y. was received too late to list the company's products in the Index Section of the Handbook and Buyers' Guide. Here are the products made by Interelectronics—enter them in your H&BG:

AMPLIFIERS, Audio Frequency, Chopper, Commercial Frequency, Magnetic, Servo, Strain-gage, Oscillograph, etc.
AUDIO-FREQUENCY EQUIPMENT
BATTERIES, Dry, Mercury and Storage
CAPACITANCE INDICATORS
CIRCUITS and COMPONENTS, Plug-in, Potted
COILS, Toroidal
CONVERTERS, Frequency, DC to AC
CURRENT REGULATORS, Including Ballast Tubes
DELAY LINES
DYNAMOTORS
FILTERS
FREQUENCY CHANGERS, Controllers and Regulators
GENERATORS, AC, Complex Wave, DC, Square Wave, Synchro
HUMIDITY-SENSITIVE MATERIALS
HUMIDITY INSTRUMENTS, Hygroscopic, including Hair, Plastics, etc.
INVERTERS, DC to AC
POWER SUPPLIES, AC, DC, High Voltage and Regulated
TRANSFORMERS, Input, Output, Interstage, including Current, and/or Potential, Laboratory, and Ultrasonic

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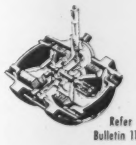
BARTON DP TRANSMITTERS accurately transmit flow, liquid level, and/or differential pressure with high speed, high sensitivity and low air consumption, regardless of **temperature** variation, **pulsation**, and severe **over-range**. Direct mechanical indicator insures continuity of operation on air failure; and together with accessible adjustments, simplifies field calibration. **For further information request bulletin 214-1 or contact BARTON sales engineers, located in most principal cities.**


Refer Bulletin 11C4
MODEL 199 METER BODY

Refer Bulletin 11C4
MODEL 200 INDICATOR

Refer Bulletin 11C4
MODEL 202 RECORDER

Refer Bulletin 211-1
MODEL 211 FLOW SWITCH

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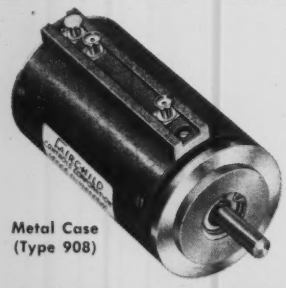
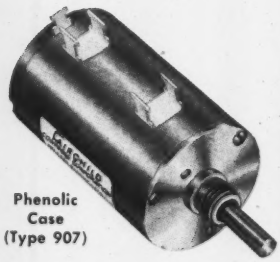


Metal Case (Type 908)

Fairchild now gives you a choice of metal or phenolic case 10-turn precision potentiometers. The rigidity of metal case construction provides *maximum* life and sustained accuracy. The phenolic case units offer the high accuracy and reliability needed to meet normal life requirements at a lower cost. To select the best unit for your application, write for more information on both metal and phenolic case potentiometers today.

TWO NEW 7/8", TEN-TURN POTENTIOMETERS

Fairchild Type 907 Phenolic and Type 908 Metal Case Precision Potentiometers are 7/8"-diameter units with 3600° electrical rotation. Type 907 has a linearity range of 0.1% to 0.50%; Type 908 has a linearity range of 0.05% to 0.25%. Both are rated at 2 watts at 40°C. Standard units rated to +85°C; higher temperature requirements can be obtained on special order. Resistance ranges from 100 to 100K ohms.



Phenolic Case (Type 907)

Write: Dept. 140-79B, Fairchild Controls Corp., Components Division, 225 Park Avenue, Hicksville, Long Island, New York. West Coast: 6111 E. Washington Blvd., Los Angeles, California.

FAIRCHILD

PRECISION POTENTIOMETERS and COMPONENTS

For more information circle **180** on inquiry card.

NEW LITERATURE

Electronic Components. Two new 2-page bulletins present data on maker's "REL-09" miniature R-F power amplifier and REL-16 air-borne power supply.—Rheem Mfg. Co., Government Products Div., 9236 East Hall Rd., Downey, Calif.

Circle **531** on inquiry card.

Scientific Instruments. New 8-page Bulletin A-25 presents specifications and prices of maker's decade resistance and capacitance standards, high linearity decade voltage dividers, etc. —Electro-Measurements, Inc., 7524 S. W. Macadam Ave., Portland 1, Ore.

Circle **532** on inquiry card.

Industrial Electronic Equipment. New 308-page illustrated Catalog 65 presents complete list of industrial electronics equipment and parts, high fidelity components and systems, radio, TV, amateur gear, etc.—Newark Electric Co., 223 W. Madison St., Chicago 6, Ill.

Circle **533** on inquiry card.

Electrical Contacts. New 4-page (August) issue of "Wilco Tech Bulletin" (Part 1) describes properties and uses of silver-cadmium oxide electrical contacts.—H. A. Wilson Co., 2655 U. S. Route 22, Union, N. J.

Circle **534** on inquiry card.

Rate Gyros, Potentiometers.—Three new 2-page Bulletins R-100, A-100 and P-100 describe maker's rate gyros, accelerometers, and potentiometers.—Humphrey, Inc., 2805 Cannon St., San Diego 6, Calif.

Circle **535** on inquiry card.

RESISTORS, POTENTIOMETERS

Potentiometer. New 2-page Data Sheet 54-87 presents specifications on maker's "T-10-A" laboratory model precision potentiometer.—Helipot Corp., Div. of Beckman Instruments, Inc., Newport Beach, Calif.

Circle **536** on inquiry card.

Potentiometer. New 2-page Data Sheet 54-49 describes maker's new 2" dia., single-turn, continuous-rotation, precision potentiometer.—Helipot Technical Information Service, Newport Beach, Calif.

Circle **537** on inquiry card.

Potentiometer. New 2-page Data Sheet 54-39 presents specifications, construction, and coil characteristics on maker's 1¼" diameter "Series 5300" precision potentiometer.—Helipot Technical Information Service, Newport Beach, Calif.

Circle **538** on inquiry card.

Potentiometer. New 2-page Data Sheet 54-26 describes maker's "Series 7700" precision potentiometers for servo or three-hole pilot mounting — Helipot Corp., Div. Beckman Instruments, Inc., Newport Beach, Calif.

Circle **539** on inquiry card.

Encapsulated Resistors. New 20-page Bulletin LC-1030BX presents maker's line of wire wound, fixed, accurate encapsulated resistors.—Cinema Engineering Div. of Aerovox Corp., Burbank, Calif.

Circle **540** on inquiry card.

Wire Wound Resistors. New 4-page Engineering Bulletin D-111 presents specifications on maker's precision wire wound resistors.—Dmeter Mfg. Co., Inc., 22-24 Larkin Plaza, Yonkers 2, N. J.

Circle **541** on inquiry card.

Potentiometers. New 2-page specification sheet describes maker's linear travel potentiometers.—Minco Engineering and Manufacturing, 801 8th St. S. E., Minneapolis 14, Minn.

Circle **542** on inquiry card.

TRANSISTORS

Silicon Rectifiers. Two new 2-page Bulletins DL-S 649 and 650 describe and give specifications of maker's "Types 1N588, 1N589, 1N590 and 1N591" grown junction silicon rectifiers.—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 6, Tex.

Circle **543** on inquiry card.

Silicon Rectifiers. New 4-page issue of "Silicon Rectifier News" (Aug. 56) SN-856 contains Application Notes for silicon rectifiers.—International Rectifier Corp., El Segundo, Calif.

Circle **544** on inquiry card.

Power Rectifiers. New 4-page Bulletin SR-A presents specifications on maker's silicon power rectifiers.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle **545** on inquiry card.

SWITCHES, RELAYS

Pushbutton Switch. New 2-page Data Sheet 111 presents maker's "Series 71PB" pushbutton switch for vending machines, applicances, commercial computers, etc.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **546** on inquiry card.

Power Switch. New 2-page Specification Sheet S 800-1 describes maker's "Electro-O-Vane" control unit.—Minneapolis Honeywell Reg. Co., Industrial Div., Wayne & Windrim Aves. Phila. 44, Pa.

Circle **547** on inquiry card.

Relays. New 4-page bulletin describes maker's "Model 266" VHS ("very high sensitivity") relay.—Assembly Products, Inc., 69-873 Rd., P. O. Box 308, Desert Hot Springs 3, Calif.

Circle **548** on inquiry card.

Sensitive Relays. Three new 2-page bulletins picture and describe maker's "Series 100" relays.—Hedin Tele-Technical Corp., 12 Carlton Ave., Mountain View, c/o Little Falls Post Office, Little Falls, N. J.

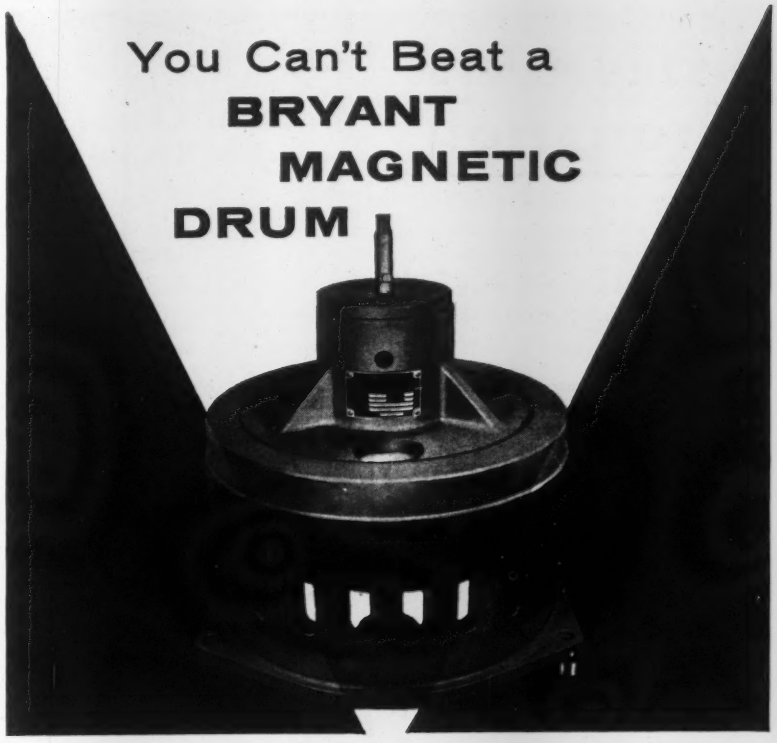
Circle **549** on inquiry card.

Relays. New 8-page brochure presents specifications on maker's general-purpose stock, special order, and subminiature relays.—Electro-Mechanical Specialties Co., Inc., 6819 Melrose Ave., Los Angeles 38, Calif.

Circle **550** on inquiry card.

Switches. New 2-page Data Sheet S-1A presents specifications on maker's push-button "B" Series switches.—Hetherington, Inc., Sharon Hill, Pa.

Circle **551** on inquiry card.



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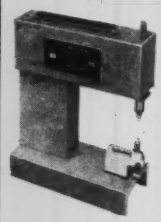

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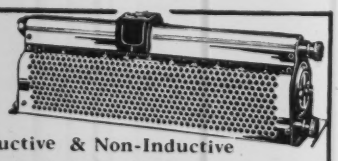

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NEW LITERATURE

CONNECTORS, WIRING

Connectors. New 2-page bulletin describes and illustrates maker's solder filled contacts.—DeJur-Amsco Corp., Electronic Sales Div., 45-01 Northern Blvd., Long Island City 1, N. Y.
Circle **552** on inquiry card.

Molded Insulators. Two new 4-page Bulletins present information on maker's integral molded insulation connectors for molded unit cables.—Alden Products Co., 117 North Main St., Brockton 64, Mass.
Circle **553** on inquiry card.

Electrical Connectors. New 8-page brochure illustrates and describes maker's complete line of miniature electrical connectors.—The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.
Circle **554** on inquiry card.

Electrical Connectors. New 20-page Technical Paper #101 gives the proceedings of the Symposium on Electrical and Environmental Connectors attended by 25 participants from the aircraft industry.—The Deutsch Co., 7000 Avalon Blvd., Los Angeles 3, Calif.
Circle **555** on inquiry card.

Conduit Metal Strap. New 2-page Bulletin SOS-856 presents data on maker's "Snap-On" metal strap for pipe, rigid and thinwall conduit.—Holub Industries, Inc., Sycamore, Ill.
Circle **556** on inquiry card.

Electric Clips. New 8-page Catalog 180 describes maker's test and battery clips used in electronic, electrical and automotive fields.—Mueller Electric Co., Cleveland 14, Ohio.
Circle **557** on inquiry card.

Electrical Wiring Devices. New 32-page Catalog 15 illustrates and describes electrical wiring devices like lamp holders, sockets, switches etc.—Kulka Electric Mfg. Co. Inc., 633 S. Fulton Ave., Mount Vernon, N. Y.
Circle **558** on inquiry card.

MATERIALS

Rubber. New 2-page issue "Facts About Hypalon" (No. 4) describes maker's Hypalon chemical resistant rubber for oxidizing agents.—Elastomers Div. of E. I. DuPont de Nemours & Co., Wilmington, Dela.
Circle **559** on inquiry card.

Silicone Compounds. New 4-page Bulletin AD-24E presents list of major categories of silicone compounds and typical properties of each.—General Electric Co., Silicone Products Dept., Waterford, N. Y.
Circle **560** on inquiry card.

Non-Woven Fabric. New 4-page bulletin presents properties and suggested uses of maker's "Allfab" multipurpose fabric.—Felters Co., 210 South St., Boston 11, Mass.
Circle **561** on inquiry card.

Wire Cloth. New folder "Quality Wire Screen" presents description of company's plant, products and services.—Cleveland Wire Cloth & Mfg. Co., 3578 E. 78th St., Cleveland 5, Ohio.
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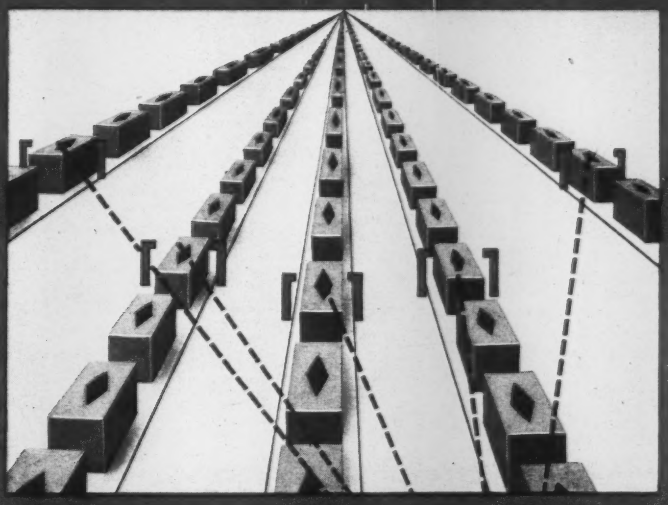

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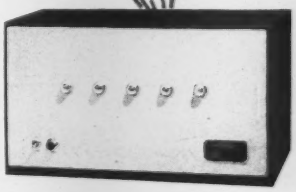

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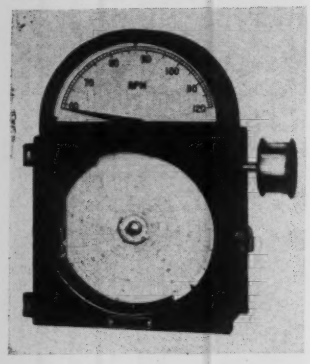

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Advertisers' Index

Accuracy Scientific Instrument Co. 2326
Acromark Company 2257
Advance Electronics Lab., Inc. 2178
AEMCO Incorporated 2274
A'G'A Division of Elastic Stop Nut Corp. of America 2296
Alina Corporation 2269
Allen-Bradley Co. 2202
American Chain & Cable Company 2317
American Machine and Metals, Inc. 2279
Amperite Co., Inc. 2265
Ampex Corporation 2179
Amthor Testing Instrument Co., Inc. 2326
Assembly Products, Inc. 2300
Associated Spring Corporation 2199
Atkomatic Valve Co., Inc. 2304
Austin Company 2294
Automatic Electric Sales Corporation 2176
Automatic Temperature Control Co. 2299

Bacharach Industrial Instrument Co. 2164
Bailey Meter Company 2227
Baker & Company, Inc. 2139, 2273, 2284, 2319
Baldwin-Lima-Hamilton Corporation 2167
Barber-Colman Company 2174
Barber-Colman Company, Wheelco Instruments Div. 2313
Barksdale Valves 2166
Barton Instrument Corporation 2321
Battelle Institute 2311
Bechtel Corporation 2324
Beckman, Inc., Arnold O. 2266
Beckman Instruments, Inc. 2255
Bell Aircraft Corp. 2271
Berkeley Division, Beckman Instruments, Inc. 2244
Black, Sivalls & Bryson, Inc. 2228, 2229
Bourns Laboratories 2150
Bridgeport Thermostat Division 2258
Bristol Company 2164, 2196-2197
Brooks Rotameter Company 2303
Brown Instruments Division of Minneapolis-Honeywell Regulator Co. 2146, 2230-2231
Brush Electronics Company 2191, 2192-2193
Bryant Chucking Grinder Co. 2323

Cambridge Instrument Co., Inc. 2163
Chatillon & Sons, John 2283
Cobehn, Inc. 2314
Cohn Corp., Sigmund 2298
Comar Electric Company 2304
Computer-Measurements Corp. 2306
C.O.M.S.I.P 2324
Consolidated Electrodynamics Corporation 2142, 2258, 2272, 2316
Cosa Corporation 2310
Crow Electri-Craft Corporation 2280
Curtiss-Wright Corporation 2269, 2318

Design Research Development 2322
Dialight Corporation 2163
Dietert Co., Harry W. 2173
Dwyer Mfg. Co., F. W. 2305

Eastman Kodak Company 2305
Electric Auto-Lite Company 2259
Electronic Associates, Inc. 2238
Electrons, Incorporated 2287
Ellis & Sons, Inc., George D. 2324
El Mec Laboratories, Inc. 2320
Electronic Engineering Company of California 2292
Eppley Laboratory, Inc. 2169
Esterline-Angus Company, Inc. 2320
Ewald Instruments 2324

Fairchild Controls Corporation, Components Division 2322
Falstrom Company 2136
Fischer & Porter Company ..... Inside Back Cover
Fisher Governor Company 2141
Fitzpatrick Electric Supply Co. 2276
Foxboro Company 2200-2201

Gaertner Scientific Corporation 2278
General Electric Company 2251, 2256
General Motors Corporation 2175
Giannini & Co., Inc., G. M. 2290
Green Instrument Company 2307
G-V Controls Inc. 2260

Hagan Corporation 2247
Hain, Inc. 2178
Hammel-Dahl Company ..... Back Cover
Hasler-Tel Company, Inc. 2305
Hathaway Instrument Division 2267
Haydon Company, A. W. 2319
Heiland Instruments 2203
Heise Bourdon Tube Company, Inc. 2270
Heitz Inc., Karl 2307
Helicoid Gage Division 2317
Hirschmann Co., Inc., Carl 2318
Hoke Incorporated 2154
Hughes Aircraft Company 2297

Illinois Testing Laboratories, Inc. 2170
Imperial Brass Manufacturing Co. 2155
Induction Motors Corp. 2147
International Business Machines Corporation 2204

Johnson Engineering Company Inc., Welton V. 2300
Jones Optical Works, A. D 2304

Kearfott Company, Inc. 2143
Kester Solder Company 2306
King Engineering Corp. 2282
Klipfel Valves, Inc. 2261

Leeds & Northrup Company 2160, 2180
Lepel High Frequency Laboratories, Inc. 2285
Lewis Engineering Co. 2144
Librascope, Inc. 2171
Lynn, Robert M. 2264

Magnatrol Valve Corp. 2308
Mallory & Co., Inc., P. R. 2263
Manning, Maxwell & Moore, Inc. 2237
Marsh Instrument Co. 2310
Marshalltown Manufacturing Co. 2262
McDanel Refractory Porcelain Company 2316
Measurements Corporation 2257
Meriam Instrument Company 2140
Mico Instrument Company 2284
Mid-Century Instrumatic Corp. 2242
Midwestern Instruments ..... Inside Front Cover
Milford Rivet & Machine Co. 2273
Minneapolis-Honeywell Regulator Co., Industrial Division 2146, 2230-2231, 2264
Moeller Instrument Company 2170
Monsanto Chemical Company 2288
Moog Valve Co., Inc. 2172
Moser Jewel Company 2308
Mueller Electric Company 2311

Nash Engineering Company 2198
National Cash Register Company 2148
Nester Company, Inc., L. G. 2284
Newark Electric Company 2273
North American Instruments, Inc. 2278
Norwood Controls 2301

Ohmite Manufacturing Company 2162
Optical Coating Laboratory, Inc. 2262
Opto-Metric Tools, Inc. 2260

Palmer Thermometers, Inc. 2276
Parker Appliance Company 2293
Perkin Engineering Corporation 2135
Permag Corp. 2321
Philadelphia Thermometer Co. 2309
Phoenix Precision Instrument Co. 2156
PIC Design Corporation 2310
Post Machinery Co. 2325
Potter Instrument Company, Inc. 2277
Pritchard & Co. of California, J. F. 2254, 2255
Production Instrument Co. 2245
Progressive Service Co. 2308
P-W Industries, Inc. 2268
Pyrometer Instrument Co. 2150

Radio Corporation of America 2315
Radio Frequency Laboratories, Inc., ... 2255, 2274
Rahm Instruments Inc. 2149
Raytheon Mfg. Co. 2309
Reeves Instrument Corporation 2168
Remington Rand Univac 2246
Republic Aviation 2194-2195
Rex Rheostat Co. 2324
Robbins Aviation 2149
Rochester Manufacturing Co., Inc. 2250
Rubicon Company 2174

Sanders Associates Incorporated 2282
Schaevitz Engineering 2173
Scherr Co., Inc., Geo. 2306
Sensitive Research Instrument Corporation 2136
Shallcross Manufacturing Company 2281
Shore Instrument & Mfg. Co., Inc. 2276
Skinner Electric Valve Division 2157
Smith Company, S. Morgan 2291
Sorensen & Company, Inc. 2153
Stackpole Carbon Co. 2311
Standard Electric Time Company 2158-2159
Statham Laboratories 2257
Stevens-Arnold Incorporated 2178
Swartwout Company 2248

Technical Charts Incorporated 2314
Technique Associates, Inc. 2309
Teletronics Laboratory, Inc. 2315
Tensitron, Inc. 2324
Tetrad Company 2138
Thermo Electric Co., Inc. 2286
Tinsley Laboratories 2282
Transitron Electronic Corporation 2295

Uehling Instrument Co. 2278
Underwood Corporation 2165
Unertl Optical Co., John 2280
United States Gauge, Div. of American Machine and Metals, Inc. 2279
United States Radium Corporation 2298

Van Keuren Company 2147
Vapor Recovery Systems Company 2289
Veeder-Root Incorporated 2249

Wallace & Tiernan Incorporated 2275
Weckesser Company 2280
Weksler Thermometer Corp. 2256
Welch Scientific Company, W. M. 2253
Weston Electrical Instrument Corporation 2161
Wheelco Instruments Div., Barber-Colman Company 2313
Wilmad Glass Company, Inc. 2307

NEW LITERATURE

MECHANICAL COMPONENTS

Micro Bearings. New Catalog and Data Book presents complete reference material on instrument bearings in 18 bulletins.—New Hampshire Ball Bearings, Inc., Peterborough, N. H.
Circle 563 on inquiry card.

Self-locking Nuts. New 6-page loose-leaf catalog presents sizes and prices for maker's line of self-locking nuts for screw sizes from #4 through ⅜".—Con-Torq, Inc., North & Judd Mfg. Co., New Britain, Conn.
Circle 564 on inquiry card.

Screw Machine Parts. New 4-page illustrated bulletin describes contract manufacturing services for design, development and manufacture of screw machine products and cold upset parts.—Chicago Screw Co., 2701 Washington Blvd., Bellwood, Ill.
Circle 565 on inquiry card.

Engine Suspensions. New 6-page Bulletin 506 describes and illustrates maker's "MR-36M Dynafocal" radial engine suspension.—Lord Mfg Co., Erie, Pa.
Circle 566 on inquiry card.

Retaining Rings. New 12-page catalog presents engineering specifications on maker's industrial retaining rings.—Industrial Retaining Ring Co., Dept. P59, 57 Cordier St., Irvington 11, N. J.
Circle 567 on inquiry card.

MISCELLANEOUS

Manufacturing Facilities. New 36-page brochure pictures and describes company's manufacturing and engineering facilities.—Librascope, Inc., 808 Western Ave., Glendale, Calif.
Circle 568 on inquiry card.

Index of Instrumentation Literature. New 24-page Bulletin G-2 covers catalogs, bulletins, specification and data sheets, illustrated lectures and articles from instrumentation Magazines.—Mineapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Phila. 44, Pa.
Circle 569 on inquiry card.

Turns-Counting Dials. New 2-page Data Sheet 54-78 pictures and describes maker's "RB" Duodial turns-counting dials for setting multi-turn devices in electrical, mechanical, hydraulic and pnuematic applications.—Helipot Corp., Newport Beach, Calif.
Circle 570 on inquiry card.

Electronic Research and Development. New 4-page brochure describes company's electronic research and development facilities.—Servo Corp. of America, 20-20 Jericho Turnpike, L. I., N. Y.
Circle 571 on inquiry card.

Hot Stamping Machine. New bulletin describes maker's "Model 2AS" hot-stamping machine for marking printed circuits.—Acromark Co., 543 Morrell St., Elizabeth, N. J.
Circle 572 on inquiry card.

Alnico Magnets. New Catalog Sheet 200 presents data on maker's bars, discs, horseshoes, rods, channels, etc.—Park Magnet Co., 1557 Green Bay Rd., Highland Park, Ill.
Circle 573 on inquiry card.

Radar Antennas, Pedestals, Drives. New 20-page booklet "Electronics Facts Handbook" presents reference data for government and industrial R

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2	27	52	77	102	127	152	177	
3	28	53	78	103	128	153	178	
4	29	54	79	104	129	154	179	
5	30	55	80	105	130	155	180	
6	31	56	81	106	131	156	181	
7	32	57	82	107	132	157	182	
8	33	58	83	108	133	158	183	
9	34	59	84	109	134	159	184	
10	35	60	85	110	135	160	185	
11	36	61	86	111	136	161	186	
12	37	62	87	112	137	162	187	
13	38	63	88	113	138	163	188	
14	39	64	89	114	139	164		
15	40	65	90	115	140	165		
16	41	66	91	116	141	166		
17	42	67	92	117	142	167		
18	43	68	93	118	143	168		
19	44	69	94	119	144	169		
20	45	70	95	120	145	170		
21	46	71	96	121	146	171		
22	47	72	97	122	147	172		
23	48	73	98	123	148	173		
24	49	74	99	124	149	174		
25	50	75	100	125	150	175		

New Instruments

201	226	251	276	301
202	227	252	277	302
203	228	253	278	303
204	229	254	279	304
205	230	255	280	305
206	231	256	281	306
207	232	257	282	307
208	233	258	283	308
209	234	259	284	309
210	235	260	285	310
211	236	261	286	311
212	237	262	287	312
213	238	263	288	313
214	239	264	289	314
215	240	265	290	315
216	241	266	291	316
217	242	267	292	317
218	243	268	293	318
219	244	269	294	319
220	245	270	295	320
221	246	271	296	321
222	247	272	297	322
223	248	273	298	323
224	249	274	299	
225	250	275	300	

New Literature

401	426	451	476	501	526	551	576	
402	427	452	477	502	527	552	577	
403	428	453	478	503	528	553	578	
404	429	454	479	504	529	554	579	
405	430	455	480	505	530	555	580	
406	431	456	481	506	531	556	581	
407	432	457	482	507	532	557	582	
408	433	458	483	508	533	558	583	
409	434	459	484	509	534	559	584	
410	435	460	485	510	535	560	585	
411	436	461	486	511	536	561	586	
412	437	462	487	512	537	562	587	
413	438	463	488	513	538	563	588	
414	439	464	489	514	539	564	589	
415	440	465	490	515	540	565	590	
416	441	466	491	516	541	566	591	
417	442	467	492	517	542	567	592	
418	443	468	493	518	543	568	593	
419	444	469	494	519	544	569		
420	445	470	495	520	545	570		
421	446	471	496	521	546	571		
422	447	472	497	522	547	572		
423	448	473	498	523	548	573		
424	449	474	499	524	549	574		
425	450	475	500	525	550	575		

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Print—fill in COMPLETELY:
INSTRUMENTS and AUTOMATION
Nov. '56
Good until 2-1-57

Name ..... Title .....
Company .....
Company Address ..... City ..... Zone ..... State .....
Products Manufactured .....
☐ Check for address change Show OLD address here: .....

Advertised Products

1	26	51	76	101	126	151	176	
2	27	52	77	102	127	152	177	
3	28	53	78	103	128	153	178	
4	29	54	79	104	129	154	179	
5	30	55	80	105	130	155	180	
6	31	56	81	106	131	156	181	
7	32	57	82	107	132	157	182	
8	33	58	83	108	133	158	183	
9	34	59	84	109	134	159	184	
10	35	60	85	110	135	160	185	
11	36	61	86	111	136	161	186	
12	37	62	87	112	137	162	187	
13	38	63	88	113	138	163	188	
14	39	64	89	114	139	164		
15	40	65	90	115	140	165		
16	41	66	91	116	141	166		
17	42	67	92	117	142	167		
18	43	68	93	118	143	168		
19	44	69	94	119	144	169		
20	45	70	95	120	145	170		
21	46	71	96	121	146	171		
22	47	72	97	122	147	172		
23	48	73	98	123	148	173		
24	49	74	99	124	149	174		
25	50	75	100	125	150	175		

New Instruments

201	226	251	276	301
202	227	252	277	302
203	228	253	278	303
204	229	254	279	304
205	230	255	280	305
206	231	256	281	306
207	232	257	282	307
208	233	258	283	308
209	234	259	284	309
210	235	260	285	310
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217	242	267	292	317
218	243	268	293	318
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222	247	272	297	322
223	248	273	298	323
224	249	274	299	
225	250	275	300	

New Literature

401	426	451	476	501	526	551	576	
402	427	452	477	502	527	552	577	
403	428	453	478	503	528	553	578	
404	429	454	479	504	529	554	579	
405	430	455	480	505	530	555	580	
406	431	456	481	506	531	556	581	
407	432	457	482	507	532	557	582	
408	433	458	483	508	533	558	583	
409	434	459	484	509	534	559	584	
410	435	460	485	510	535	560	585	
411	436	461	486	511	536	561	586	
412	437	462	487	512	537	562	587	
413	438	463	488	513	538	563	588	
414	439	464	489	514	539	564	589	
415	440	465	490	515	540	565	590	
416	441	466	491	516	541	566	591	
417	442	467	492	517	542	567	592	
418	443	468	493	518	543	568	593	
419	444	469	494	519	544	569		
420	445	470	495	520	545	570		
421	446	471	496	521	546	571		
422	447	472	497	522	547	572		
423	448	473	498	523	548	573		
424	449	474	499	524	549	574		
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NEW LITERATURE

& D activities.—American Machine & Foundry Co., 261 Madison Ave., New York 16, N. Y.
Circle 574 on inquiry card.

Machine Mountings. New 8-page brochure K7A "So You Want to Increase Production!" presents case histories on how profits and production can be increased through vibration-and-noise-control machinery mountings.—Korfund Co., Inc., 48-35 J 32nd Place, Long Island City 1, N. Y.
Circle 575 on inquiry card.

Instrument Cases. New 4-page bulletin illustrates maker's line of drawn aluminum instrument cases.—Instrument Cases, Inc., 510 Garfield St., Glendale 4, Calif.
Circle 576 on inquiry card.

Mounting Bases. New 4-page Bulletin 705 pictures and describes maker's "Radiofocal" mounting bases for aircraft electronic equipment.—Lord Mfg. Co., Erie, Pa.
Circle 577 on inquiry card.

Drawing Supplies. Two new folders describes and illustrates maker's beam and bow compasses and "Model 17" Ellipsograph.—Omicron Co., P. O. Box 907, Glendale, Calif.
Circle 578 on inquiry card.

FABRICATION

Rosin Flux. New 2-page Bulletin 1 presents description of maker's #100 liquid rosin flux for electrical, electronic, printed circuit soldering, etc. —Alpha Metals, Inc., 56 Water St., Jersey City, N. J.
Circle 579 on inquiry card.

Mold Compound. New 2-page Bulletin 12 presents applications, physical properties and methods of mixing and using maker's "Poly-Flex 100" cold-setting flexible mold compound. —Smooth-On Mfg. Co., 572 Communipaw Ave., Jersey City 4, N. J.
Circle 580 on inquiry card.

Processing Machinery. New folder contains bulletins describing maker's automatic encapsulating machines, single tank and dual impregnators, vacuum systems and pumps, diplids, etc. for the electronics industry.—Red Point Products, Inc., Glendale 1, Calif.
Circle 581 on inquiry card.

Chucks, Holding Fixtures. New 4-page folder contains data sheets on maker's chucks and holding fixtures. —Garrison Machine Works, Inc., Dayton 4, Ohio.
Circle 582 on inquiry card.

Threading Tools. New 4-page illustrated catalog on maker's line of miniature taps, dies, screws, drills and tools.—J. I. Morris Co., 394 Elm St., Southbridge, Mass.
Circle 583 on inquiry card.

Form and Punch Shaper. New 4-page illustrated brochure describes maker's "Jemco K-150" form and punch shaper which produces high precision punches.—Jersey Mfg Co., 432 Livingston St., Elizabeth, N. J.
Circle 584 on inquiry card.

Manufacturing Facilities. New 8-page brochure describes company's research, engineering and development facilities.—Allied Research Associates, Inc., 43 Leon St., Boston 15, Mass.
Circle 585 on inquiry card.

Resistance Welders. New 4-page bulletin 8-56 describes maker's "S" multiple standard electrode resistance welders.—Sciaky Bros., Inc., 4915 W. 67th St., Chicago, Ill.
Circle 586 on inquiry card.

Silver Plating. New 4-page brochure describes maker's "Sel-Rex" high-speed silver plating process for industrial applications.—Sel-Rex Precious Metals, Inc., Dept. PS-1, Belleville 9, N. J.
Circle 587 on inquiry card.

Electroplating Agitator. New 2-page data sheet pictures maker's "Turbomatic" agitator used for precious metal electroplating solutions.—Technic, Inc., Providence, R. I.
Circle 588 on inquiry card.

Compounds and Solvents. New 8-page bulletin presents maker's complete line of industrial cleaning compounds and solvents.—Brulin & Co., Inc., 2939-45 Columbia Ave., Indianapolis 7, Ind.
Circle 589 on inquiry card.

Rotary Finisher and Buffer. New 2-page data sheet presents specifications on maker's rotary finisher and buffer with disc attachment.—Mathewson Machine Works, Inc., 2 Hancock St., Quincy 71, Mass.
Circle 590 on inquiry card.

Stock Feeder. New 2-page bulletin describes maker's strip stock feeder for blanking hot or cold laminated plastic or fiber parts.—Technical Design & Development Co., Inc., 435 Naugatuck Ave., Milford (Devon), Conn.
Circle 591 on inquiry card.

Adhesive Bonding. New 4-page brochure describes company's adhesive bonding service for guided missile, aircraft and electronic industries.—Metal Bonding Div., Electro-Kinetics Corp., 1511 Colorado Blvd., Santa Monica, Calif.
Circle 592 on inquiry card.

Conductive Coating. New 4-page bulletin describes maker's "RS 1" very-low resistance shielding micro-paint, and "RS 17" polyshield micro-paint.—Micro-Circuits Co., New Buffalo, Mich.
Circle 593 on inquiry card.

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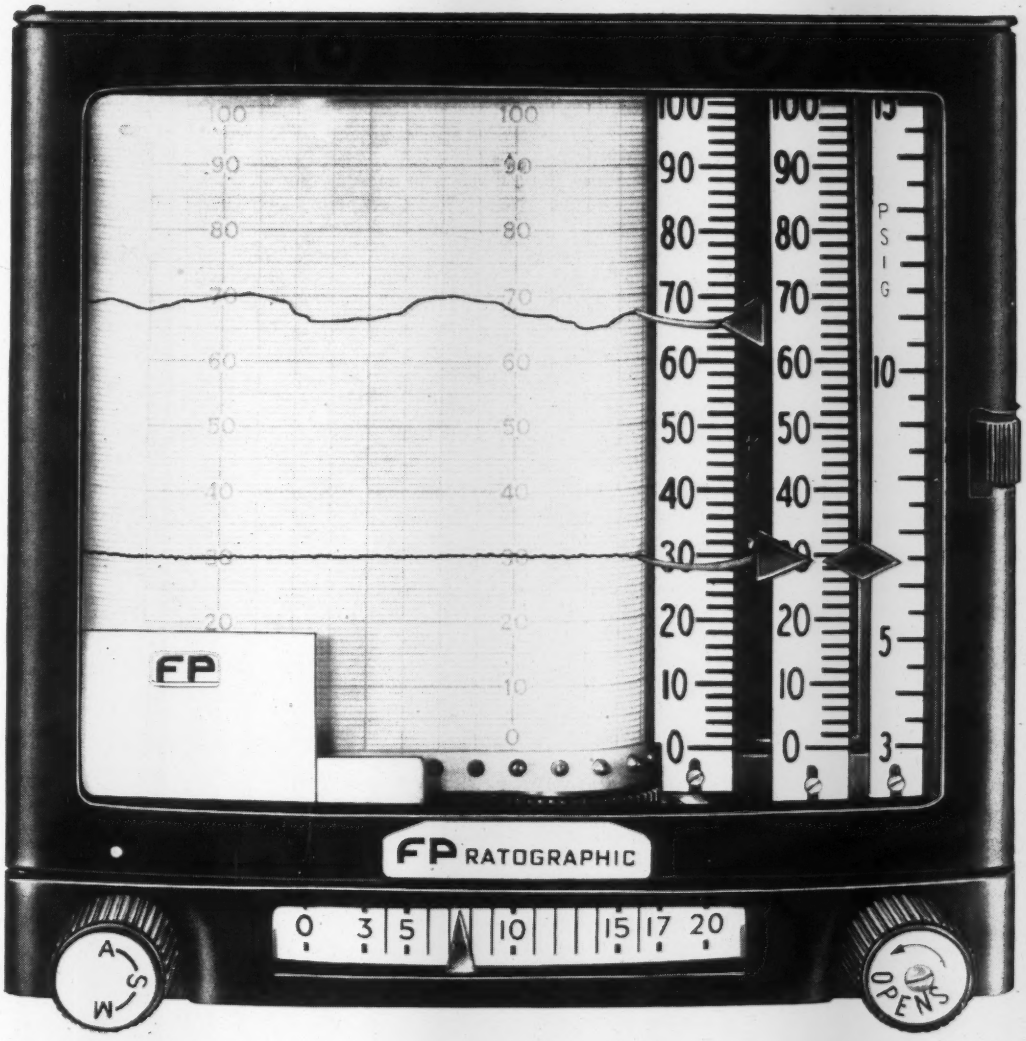


Fischer & Porter has the answer... it's *READABILITY*

Look at the actual size illustration above. Notice how horizontal chart travel assures quick, easy readability. Side writing pens mean accurate reading of chart record. The entire instrument may be withdrawn from case, making visible a 14 hour chart section, *without interrupting operation of the recorder or controller in any way*. There are no other instruments like these using full four inch charts.

F&P Ratographic Recorders may be quickly interchanged from the *front* of the panel. Servicing is simple. Automatic seal-off. Consider the continuous chart rewind with handy daily tear-off. Consider the removable pens, fed from an adequate ink supply reservoir. Yes, consider *all* the F&P Ratographic advantages and you'll buy no others.

These instruments mount readily on conventional or graphic panels. Specify any of many options and F&P has the answer. A single F&P Ratographic Recorder in use will convince you of their versatility, high accuracy and dependability. That's a firm assurance. Write today for complete information or specific quotations. Fischer & Porter Co., 416 County Line Road, Hatboro, Penna.

Illustrated Literature on Request

Catalog 55-20 is a complete, detailed report on the multiple applications, the many options available in F&P Ratographic instruments. Write for it today. No obligation, of course.

FP FISCHER & PORTER CO. Hatboro, Pa.

COMPLETE PROCESS INSTRUMENTATION

For more information circle **91** on inquiry card.

HAMMEL-DAHL®

CONTROL VALVES

designed for:

LARGE FLOWS

(dP up to 3600 PSI)

Venturiflo Angle Valve 1" - 12"

GENERAL PURPOSE

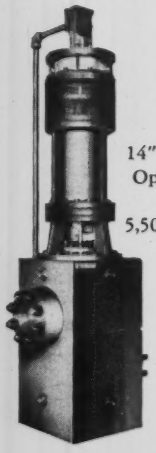
Standard Globe Valve ½" - 16"

SMALL FLOWS

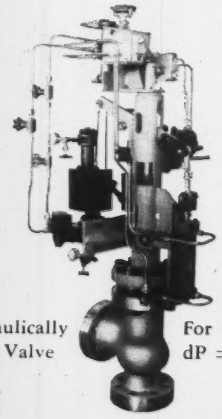
(From Cv Max. = 12 To Cv Max. = 0.000010)

MicroFlo Angle Valve ½" - 1"

OR YOUR SPECIAL APPLICATIONS



14" Magnetically Operated Valve For 5,500 PSI Service



8" Hydraulically Operated Valve

For Gas Service dP = 2230 PSI

6" Spring-Loaded Piston Operated Valve

For 600 PSI Steam @ 750°F.

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175 POST ROAD, (WARWICK) PROVIDENCE 5, R. I., U. S. A.

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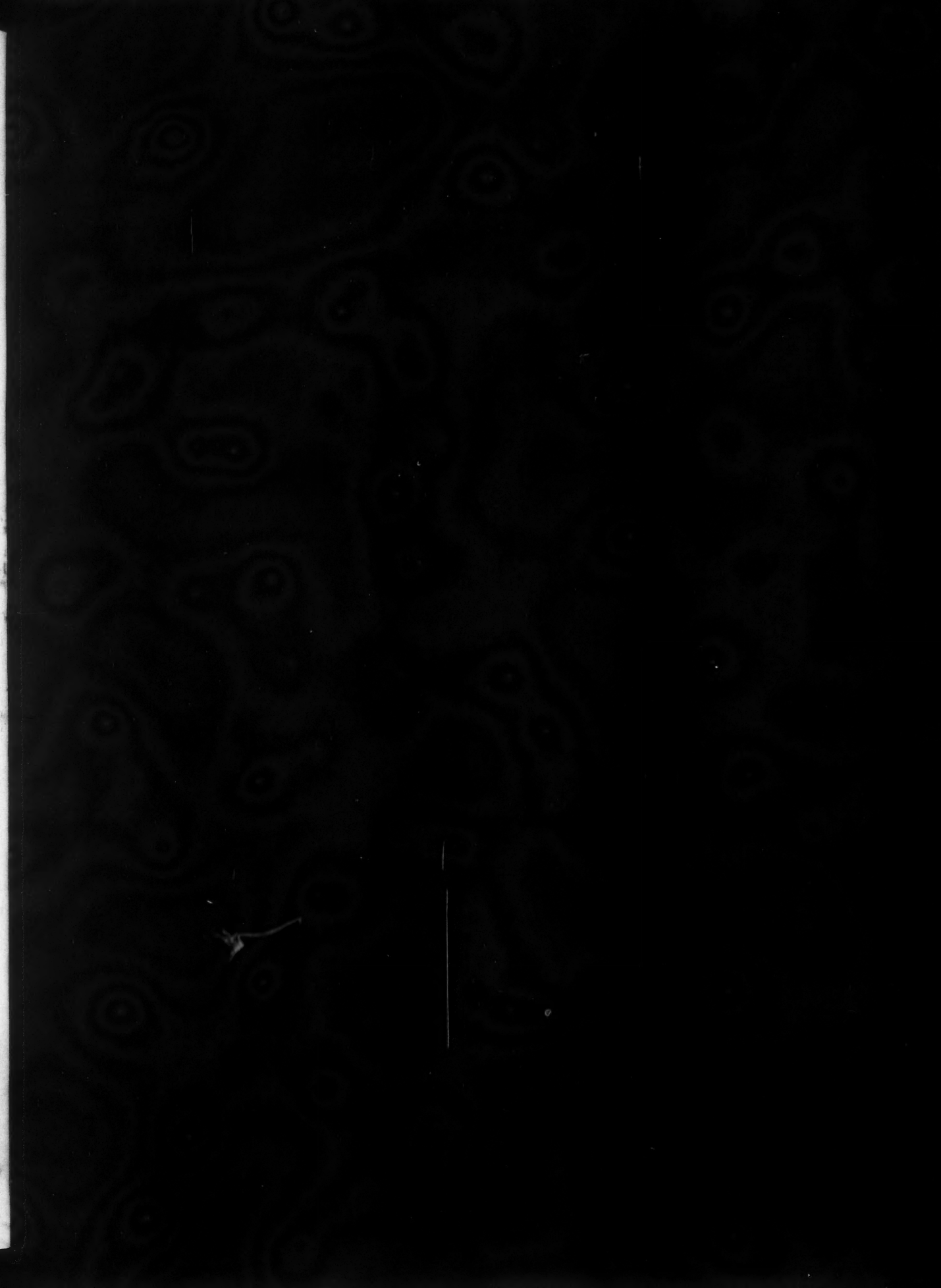
CANADIAN MANUFACTURING AFFILIATE—GUELPH ENGINEERING CO., GUELPH, ONT.

For more information circle **188** on inquiry card.